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Part I.

OCCUPATION.

Hygiene of Occupation.

BY

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HYGIENE OF OCCUPATION.

The first author who studied the relation between the habitual occupation of men and their physical and mental health was Bernardini Ramazzini, who published a treatise, "De morbis artificum," at Padua, in 1713. The work seems to have attracted immediate attention, for we find another edition published at Geneva in 1717, and it was followed by treatises in French, being itself translated into the latter language in 1777, by Fourcroy. The work of Ramazzini is even now a striking one, both on account of its fulness of treatment and its intensely pessimistic views of the condition of the artisan. This extremely melancholy view of the effect of occupation on the health has been attributed, and probably with truth, to the fact that he did not sufficiently distinguish between the direct effect of the occupation and the influence of the home surroundings and food. The elimination of outside influences is not even now an easy one, and still it is evidently unscientific and unproductive of any good result whatever to describe as due to the occupation diseases whose prevalence is mainly caused by bad food, insufficient sleep, or bad ventilation or drainage.

The diseases fairly chargeable to the occupation of an individual are those which can be traced to the conditions under which he works, the strain or effort to which special organs are subjected, and the actual contact with substances which produce changes by reason of their mechanical or chemical qualities. Thus, he may be constantly obliged to work in a room where the air is filled with dust, vapors, or gases of an irritating or poisonous nature, or he may be necessarily exposed to great heat, cold, or wet, or to sudden variations of temperature. He may develop certain muscles at the expense of others, and so produce deformities of various kinds, as humpback, subluxations, bandy-legs, knock-knees, etc., or a strain upon particular organs may cause disease of those organs, as visual, cerebral, or laryngeal troubles. The contact with chemical irritants may cause cutaneous disease or actual poisoning, and the mechanical irritation of tools, etc., by intermittent pressure, will produce callosities and bursæ. Excessive effort may cause hernias or heart disease, rupture of muscular fibres, or even fractures of bones. And, under peculiar conditions not well understood, incessant use of a particular set of muscles in a certain way may bring on a spasm or cramp, which prevents their further use in that particular manner, and forces the patient to change his occupation.

The enormous impulse given to manufactures of all kinds by the utilization of steam has already made a great change in the physical conditions under which the laborer works. The employment of a great amount of capital in a single establishment enables the proprietor to furnish roomy shops and special means of ventilation in place of the contracted dwellings or small, ill-ventilated shops in which private workmen once had to labor. The greater facilities possessed by large establishments for the disposal of their goods also enable them to be content with smaller profits and so undersell the small proprietor, a course which seems to be gradually transferring the fixed capital of the whole commercial world into the hands of a few persons. This gradual massing of wealth is, however, attended with its benefits to the artisans themselves. Notwithstanding some exceptions, workmen, as a rule, work under healthier conditions and receive better wages in large factories than when they work by themselves at home. A somewhat striking illustration of this is given by Hirt in the case of weavers in Germany. An industrious, skilful weaver, according to his statement, working at home on his own loom, can earn on an average 2 thalers ($1.43) a week, or, on very fine work, 2½ thalers. His wife and children earn a little besides, so that the total average family income amounts, with slight variations, to about 100 or 120 thalers a year. Of this he pays 25 for dwelling and fuel, 5 for school money and sundries, so that he has about 90 thalers left for food and clothing. The morning meal of such a family consists of meal soup and potatoes, with rye coffee. At noon they have bread and potatoes, and in the evening meal soup and potatoes. They cannot afford meat, excepting on Sundays and holidays, when they may have half a pound of veal for the whole family. In some places there are knackeries, where horse-meat can be bought for about six cents a pound, but it is mostly sold in the form of sausages, stuffed with fat and hard to digest; its nutritious value is small, and it often causes severe gastric catarrh. The dwelling-space is very contracted, two or three families often living in one room, which is quite dark, owing to the small size and dirty condition of the windows—which are, in addition, almost always nailed up so that they cannot be opened, and drip with the condensed moisture of the oppressive atmosphere of the room. In vivid contrast with the condition of these poor people is that of the factory hands, who work in large rooms, where there is hardly any dust or bad odor, where the air is quite fresh and frequently changed, and they can earn from 2½ to 5 thalers a week, with less labor and less risk to their health.

But although the sanitary surroundings of the workmen, as regards ventilation and light, together with the hours of labor, wages, and consequently food and clothing, are growing gradually better, certain new dangers have been introduced by the new processes of manufacture, which have not yet been fully met. Striking examples of these are seen in the manufacture of matches, and of chemicals such as potassium bichromate, quinine, etc., and the use of such agents as carbon bisulphide and the brilliant colors produced by various compounds of arsenic.

Since the dangers incident to various occupations have been brought to public notice, it has become a grave question how far the employment of women and children in factories should be allowed. Women are certainly more delicately organized than men, less capable of sustained muscular exertion, and more susceptible to many of the poisons used in the arts and manufactures. As the physical condition of women has such an important bearing on the welfare of the race, and on the health of future generations, it becomes fairly a question of government control.

The same is true with regard to children. They are soon to be men and women, and constitute the sinew of the country. It is of supreme importance for the existence of any nation that the physical and mental health of its children and youth should be carefully guarded and kept at its highest possible point. But, in the formative period of life, constant and powerful impressions of any kind leave their mark, when they fail to in any way alter the iron frame of the adult. In England, in past times, little creatures of six have been made to work all day in factories, and the distortion of the limbs produced by the constrained attitude they were obliged to assume was so great and so universal as to give rise to the term "factory-leg," a form of bandy-leg, with a partial subluxation of the tibia on the femur. It is to be remembered that many of the epiphyses are not united with the bony shaft until the fourteenth or sixteenth year, that the substance of the bone is so soft and yielding that "greenstick" fractures occur, and that the function of hematosis is so imperfectly established that comparatively small losses of blood in children produce serious results, and that lack of fresh air and exercise produces anæmia and debility in them much sooner than in adults. According to Hirt the curves of the spine even, which are so pronounced in adults, are lacking at birth, and do not appear until the seventh year, and really result from muscular exertion and the weight of the body. One might certainly infer from this that, if a human being lay on his back from birth, these curves would never appear; but they are, notwithstanding, plainly indicated in the fœtus or new-born child, as may be seen from the photographs of frozen sections in Plates XI. and XIII. of Part I. of Rüdinger's Topographisch-chirurgische Anatomie. Some interesting figures are given by Layet (p. 59), showing quite clearly the influence of factory labor on the health of the young. Out of 10,000 conscripts from ten agricultural departments of France, 4,029 were rejected on account of small stature, rachitism, various infirmities or feebleness of constitution, while in the Marne, the Seine-Inférieure, the Eure, etc., manufacturing districts, there were 14,451 rejected to 10,000 found fit for the service.

Such considerations as the above have induced most governments to frame laws for the protection of children against the rapacity of parents and employers, and to prescribe quite in detail the time and manner in which their labor may be availed of. Legislation of this kind has been most extensive and complete in England, and her example has been followed to a greater or less degree by many other countries of Europe and some of the United States. The first Factory Act was passed in 1833,

and additions and emendations have been made at intervals, ten in all, up to the last act of 1878. The act of 1874 provides that no child under ten shall be employed in a factory regularly, excepting in textile industries and small shops with less than 50 employés, where they may be employed at 8 years of age. Children from 9 to 13, youths up to 18, and women of every age over 18 can be employed only from 6 to 6, or from 7 to 7. Children, young people, and women are forbidden to eat their meals in the work-rooms, and must have two hours for meals, one of them at least being before 3 P.M. Children, young people, and women must not work longer than 4½ hours on a stretch, without a pause of at least half an hour. On Saturdays they are allowed to work only till 12:30 or 1 o'clock, or, if a recess is allowed, until 1:30. Children who work under these rules all day long must have every other day free. If they work every day, they must be employed from 6 to 1, or from 12 to 6, *i. e.*, half the day. They must not be made to work Saturdays, Sundays, holidays, or by night. Inspectors are appointed by the government, whose duty it is to visit all factories in their districts, and see that these provisions are carried out and the legal penalties enforced against employers who disregard them. The act of 1878 facilitates such inspection and regulation.

In France, only children over 12 can be employed regularly in factories, excepting in certain special trades which are named, at which those of 10 years old may work, but only 6 hours a day. Night work is only allowed to those over 16, and to girls over 21. With few exceptions, children under 13, girls, and women, cannot be employed in subterranean labor.

In Germany the age at which children may be set at work in factories is fixed at 12 years, and in Switzerland at 14.

In the United States similar laws exist, so far as I have been able to learn, in only three States. In Massachusetts, children under 10 are forbidden to be employed regularly in factories, while in Rhode Island the limit is fixed at 12, and in Pennsylvania at 13.

All of the laws hitherto passed on this subject seem to be merely tentative. It has been observed that the quality of the national body and mind was being injured by the stunting effect of work on those of tender years, and so lawgivers have tried to regulate the matter empirically, without consideration of the physiological principles involved. Instead of saying, "This child began factory-work at eight and was injured thereby, and so hereafter no child shall work until he is nine," it should be considered that just previous to puberty occurs the most rapid growth of any age, and that during this time, say from 11 to 14, and while the sexual evolution is in progress, the stamina of the child is taxed to the utmost. He or she should at such a time be engaged in the most healthful occupation of body and mind—not subjected to great fatigue, and should be so employed that, whenever it appears advisable, the habitual occupation can be intermitted. This intermission is possible if the child is only employed at home or in school, but not under the inexorable discipline of a factory. I think, therefore, that eventually the laws will be so framed as to either prevent the employment of children in factories before the age of puberty,

or render their employment under that age liable to irregular interruptions, and therefore a well-recognized commercial risk. The age at which they may first be employed will either be fixed arbitrarily at 14 or 15, or will be left to the judgment of a medical inspector. Between 14 and 20, the youth is still immature, although capable of considerable endurance, and he or she should not be allowed to work more than eight hours a day at the most. After this age, the hours and methods of labor may safely be left to be determined by the law of competition.

In all cases, growing persons and women should not be allowed to work in places where they are subjected to the influence of poisons, such as lead, mercury, phosphorus, etc. Besides their deleterious effect upon the growing body, they are peculiarly injurious to the sexual health of women, and produce menstrual irregularities and abortions. This has been abundantly proved in the case of lead and mercury, and possibly of tobacco.

All factories should certainly be under sanitary supervision, and all laws for the protection of women and children in this regard rigidly enforced. Hirt thinks that every workman in a factory should undergo medical examination, and those unfitted for particular trades should be forbidden to work at them. A narrow-chested man, for example, with phthisical tendencies, should not be allowed to work at dry grinding, but only the robust and vigorous. This advice seems of doubtful value. If carried out, it would certainly result in putting the best physical material in the nation into the most destructive occupations, and end in a pronounced deterioration of the national stamina. This very thing has been long practised in the military service, and political economists have bewailed the fact that war weeded out just the flesh and blood that the nation most needed, and left all the consumptives and imbeciles at home to propagate their species. In the army such rules, however, are imperatively necessary, for consumptives are no more fit for soldiers than for fathers; but to choose such a method of depreciating the stock deliberately where it is not necessary, would seem to be very undesirable, to say the least. The contrary would better serve the interests of the race, viz.: to encourage the weakly to work at the injurious trades, and discourage the vigorous. A certain amount of selection in this respect is brought about even now by natural laws, and we find the feeble taking of their own accord to sedentary and confining occupations, while the giants alone can carry on the operations of a great forge or smithy.

The classification of the various occupations for the purposes of this chapter is a matter of much difficulty. Almost every occupation exposes its followers to more than one source of danger. Thus, a hatter is exposed to dust in sorting and cleaning the hair of which felt is made; to the poisonous effects of mercury, which he uses to separate the hair from the hide; to acid fumes, and to odors more or less offensive from the glue or size used in stiffening. The iron-puddler is subjected to sudden extremes of heat and cold, to the effects of excessive muscular effort and to the dazzling light from the mass of molten metal. It is therefore

necessary to classify occupations according to what seems to be the chief source of injury connected with them, and in this respect there will naturally be much difference of opinion.

The classification, to which I shall adhere as closely as possible, is the following:

I.

Occupations involving the introduction of deleterious matters into the body.

1. *By Inhalation.*

- A. Vapors and Gases.
  - *a.* Irritating. Metal-refiners, gold- and silversmiths, jewellers, electrotypers, etchers, bleachers, straw-hat makers, manufacturers of chemicals.
  - *b.* Poisonous. Gasmen, gilders, mirror-makers, brass-founders, match-makers, rubber manufacturers, smelters, manufacturers of aniline, photographers, cloth-scourers.
  - *c.* Offensive. Brewers, butchers, fellmongers, leather-dressers, tanners, gut-cleaners, tripe- and head-cleaners, fat-renderers, lard-refiners, bone boilers, glue-makers, fertilizer manufacturers, pork-packers, soap-makers, oil-pressers, cheese-makers, scavengers, sugar-refiners, fullers, hostlers, dog-fanciers, rag-pickers.
- B. Dust.
  - *a.* Irritating.
    - Metallic. Bronzers, file-cutters, fitters, grinders, needle-makers, pin-pointers, cutlers.
    - Mineral. Cement-makers, stone-cutters, potters, lime-burners, plaster-burners, glass-cutters, sand-blast operatives, diamond-cutters, lithographers.
    - Vegetable. Chimney-sweeps, moulders, millers, cotton, flax, and hemp operatives, tobacco operatives.
    - Animal. Brush-makers, button-makers, feather, wool and silk operatives.
    - Mixed: Carpet-cleaners, hair-pickers, street-sweepers.
  - *b.* Poisonous. Artificial-flower makers, wall-paper makers, hatters, enamellers, painters, type-founders, white-lead manufacturers, workers in copper.

2. *By Absorption.*

1. Irritating substances: Domestics, washerwomen, grocers.
2. Poisonous: Pæderasts, prostitutes.

II.

Occupations involving exposure to conditions that interfere with nutrition.

1. *Elevated or Variable Temperature.*

- *a.* Vicissitudes of weather. Boatmen, fishermen, farmers (florists, gardeners, nurserymen), drivers (cartmen, hackmen, omnibus-drivers), laborers, bricklayers, masons.
- *b.* Artificial heat. Brick-makers, bakers, cooks, charcoal-burners, blacksmiths, engineers, stokers, forgemen, iron-puddlers, glass-blowers, dyers, laundresses.

2. *Over-use of Certain Organs.*

a. Nervous system (mental worry). { Brokers, gamblers, merchants, physicians, tea-tasters.

b. Eyes. { Engravers, lapidaries, watchmakers, seamstresses (embroiderers, lace-makers).

c. Vocal organs : Actors, clergymen, singers, public speakers.

d. Muscles. { Athletes, copyists, musicians (pianists, violinists, brass-instrument players).

3. *Constrained Attitude.*

Printers (compositors, pressmen), coopers, carpenters, cabinet-makers, shoemakers, tailors, salesmen and women.

4. *Sedentary Life.*

Artists, clerks, lawyers, literary men, students, teachers.

III.

Occupations involving exposure to mechanical violence.

1. From machinery : Factory operatives, machinists, railway employés.
2. From preventable accidents : Lumbermen, quarrymen, roofers.
3. From variations in atmospheric pressure: Aëronauts, caisson-workers, divers, boiler-makers.

Besides the diseases which may be considered due to occupation, there are certain anomalies of nutrition, which are rather to be classed as compensatory physiological changes than as actual disease. Such are the thickening of the skin and development of bursæ in parts subjected to friction and pressure from the tools used in a trade. Some of the marks thus produced are quite characteristic of the trade which causes them, and thus become important from a medico-legal point of view. The "professional hand," as it has been called, has been the subject of elaborate investigation in France, and in fact most of the information to be gathered on these marks can be traced to the papers of Tardieu and Vernois, the latter especially comprising nearly all that is known about the subject. Interesting and of some importance for similar reasons are the stains left by substances used in the arts and manufactures, which also, in certain cases, may furnish a clue to personal identity. The most important of these various marks, although not strictly diseases, will be mentioned under the appropriate headings, and will also be found tabulated for convenient reference at the end of the chapter.

I.

Occupations involving the introduction of deleterious matters into the body.

These matters may exist in a gaseous form or as dust in the air, and be introduced into the body through the respiratory mucous surface, *i. e.*,

by *inhalation*, or enter it through the other mucous surfaces or the skin, *i. e.*, by *absorption*.

1. *Occupations in which individuals are exposed to the* INHALATION *of deleterious matters.*

A.—Vapors and Gases.

The foreign vapors, gases, and fumes which exist in the air of many workrooms and are necessarily inhaled by the workmen, may be broadly divided into three classes: those whose principal effect is local and consists in *irritation* and stimulation of the mucous membrane of the air-passages, those whose chief effect is a *poisonous* one and is brought on by the absorption of the noxious substances into the blood, and those whose most marked characteristic is their *offensive* odor.

a. *Occupations which expose persons to the inhalation of* IRRITATING *gases or fumes.*

The gases included under this heading are mostly *ammonia*, *chlorine*, *sulphurous*, *hyponitric*, *nitric*, *hydrochloric*, and *hydrofluoric* acids. They differ very much in the degree of irritation they cause, and in the ulterior consequences of such irritation.

The immediate result of an exposure to these fumes is cough and an increased secretion of mucus from the throat and nose, with in some cases lachrymation and sneezing. When they are in small quantity the only symptom may be a tickling, harassing cough, and when in very large quantity they may cause sudden spasm of the glottis, or even œdema, so as to threaten suffocation. Attacks of coughing due to such irritation may occasionally be followed by bloody sputa, owing to the general congestion of the mucous membrane.

The ultimate results of the inhalation of such fumes are catarrhs, the acute forms being less common than the chronic. These chronic catarrhs sometimes eventually produce bronchiectasis and emphysema, and occasionally spasmodic asthma. As in all chronic catarrhs, the retention of mucus or blood, or small local pneumonias, may lead to the caseous degeneration of portions of the lung, and finally to one form of phthisis.

According to Layet, the acid atmosphere of such workrooms is very destructive to the teeth, and those who are exposed to it lose these organs at an early period.

It is to be borne in mind that certain of these acids (sulphuric, nitric) are used in medicine as tonics, and there are facts going to show that when taken into the system in the gaseous form, through the lungs, they have a tonic effect. Angus Smith found that in some of the manufacturing districts of England the people were in the habit of bringing those sick with pulmonary diseases to the vicinity of factories which gave forth acid fumes in sufficient quantity to destroy vegetation, and reference has already been made in the chapter on Public Nuisances to the report of

the Belgian Commission regarding the apparent beneficial effect of such fumes on the public health. Hirt found that the air of workrooms usually contains only 1 or 2, or at the highest 3 per cent. of sulphurous gases, but he found in exceptional cases 7 per cent., and very rarely (in straw-hat factories) 15 per cent. According to his observations 4 per cent. does not injure the health of the workmen ; from 5 to 7 per cent. causes lung diseases, but principally affects the digestion; 10 per cent. causes severe cough and inflammation of the conjunctiva. Great numbers of workmen suffer from loss of appetite, heartburn, irregularity of the bowels, etc.; but some find their appetite increased, so much so as to eat even double their ordinary ration of food.

Some of these fumes are more liable to produce particular diseases than others, and the difference is not to be explained simply by a difference in the degree of irritation produced. Catarrhs result most commonly from the inhalation of the nitrous fumes—less often from the sulphurous; they are occcasionally due to chlorine, while hydrochloric acid very rarely produces them. On the other hand, hyponitric fumes, which oftenest cause catarrh, never according to Hirt produce pneumonia, while this disease is not rare from the inhalation of chlorine, and in such cases generally turns out badly. Falk (quoted by Hirt) describes pneumonia with circumscribed gangrene as due to chlorine gas, and Eulenberg thinks that, after a long exposure to a small proportion of this gas, complete hepatization of the lung may take place. Fluosilicic acid fumes may cause pneumonia, and also the vapors of ammonia and lime. Ammonia is said to be particularly apt to produce emphysema.

Occupations.

The "wet" method of *refining metals* has been already described in the chapter on Public Nuisances. The nitrous or sulphurous fumes which are disengaged are very irritating to the workmen, but, by proper apparatus, may be almost entirely condensed.

Goldsmiths, *silversmiths*, and *jewellers* are exposed to various kinds of fumes. They clean small articles made of copper, and prepare them for gilding by dipping them into nitric acid. Fumes of hyponitric acid rise, and are said to have even caused death when inhaled almost pure. The sweepings of their shops are burned, and the ashes treated with mercury, to obtain the gold which is always found in them. The mercury is then driven off in vapor. If this operation is carried on in the shop, the workmen are of course exposed to mercurial fumes and the danger of poisoning. The habitual contact with acids irritates the skin of the hands, and may even bring out on the palms a psoriasiform eruption (Layet). Where the galvanic method of gold- and silver-plating is employed, there is a considerable evolution of hydrogen from the decomposition of the water in the cells, sometimes enough to seriously affect the constitution of the air of the workroom. These artisans, moreover, take a most constrained attitude at their work, with their bodies bent forward, their head bowed, and the

chest narrowed in front, and frequently contract phthisis. Hirt states that three-quarters of all the deaths among goldsmiths are due to this disease, though statistics differ as much here as in all other mortality lists. The proportion of deaths from phthisis are given by Hannover (Copenhagen) at 38 per cent., and by Trebuchet (Paris) at 20 per cent. (Layet).

Electrotypers are exposed to the same influences as the electro-platers above spoken of.

Etching is done upon plates of metal or on glass. In the former case, the artists are exposed to the fumes of hyponitric acid, and to the irritation of the nitric acid wherever it comes in contact with the skin. In etching on glass hydrofluoric acid is used, which is highly corrosive and a violent poison. This acid produces painful ulcerations of the hands, and in a gaseous form intense coryza and bronchial catarrh, with irritation of the conjunctiva.

Workmen may be protected to a considerable extent from the nitrous fumes by having the operations which evolve them carried on in compartments with glass sides or top, or under hoods which are connected by a shaft with the chimney, or with an upright shaft communicating with the external air. The circulation in such a shaft may be kept up by a gaslight. If necessary, a mechanical fan or blower driven by steam may be used in large factories.

As hydrogen is so much lighter than air, any amount of it is easily disposed of by having two upright shafts extending above the roof, and differing three or four feet in their height.

It has been proposed in France by Hillairet, and recommended by the sanitary authorities there, to supply the workmen with flasks of ammonia, which volatilizes at ordinary temperatures, and forms with the nitrous gases innocuous compounds of ammonium nitrate and nitrite.

Etchers are to be protected by similar means, but, as the fumes to which they are exposed are very corrosive, the ventilation must be very carefully attended to, and the workmen should wear gloves. Layet suggests, singularly enough, that the work be done under covers, with openings for the arms, and glass to facilitate vision (!), as if the glass would not rapidly lose its transparency. Etching by means of hydrofluoric acid has been to a considerable extent superseded in this country by the sand-blast.

Bleachers of cloth are exposed to chlorine gas, and sometimes suffer from it, but as a rule the amount inhaled by them is harmless. According to Hirt, the men who manufacture calcium chloride, and inhale chlorine gas in large amount, almost all complain of loss of the sense of smell, but no such effect is noticed after the mild doses which bleachers get. Experiments on animals have shown that one part in five of this gas produces cough, bronchitis, pneumonia, and even spasm of the glottis and death. Of course such consequences are never felt by workmen. Besides chlorine, however, bleachers have to work with hot water and strong lye, and the skin of the hands is blanched and softened, often cracked and fissured. The forearms are often covered with eczematous eruptions or furuncles.

Straw-hat makers inhale more or less sulphurous acid gas. Fine hats

are first bleached in a solution of calcium chloride, and then dried and brushed. The brushing disengages considerable dust, and if, as is sometimes the case, it contains white lead, saturnine poisoning may result. The hats are afterward exposed to the fumes of burning sulphur in closed boxes, and when these leak through carelessness the fumes pervade the workroom, rarely, however, in sufficient volume to injure those present.

Manufacturers of chemicals inhale many substances of an irritating nature, including nitric, sulphuric, oxalic, and picric acids, ammonia and ammonium carbonate, soda, sulphate of quinine, and potassium bichromate. The effects produced by the inhalation of acid fumes have been already described.

In the manufacture of *ammonia* and *ammonium carbonate*, almost unavoidably some of the gas will escape into the atmosphere of the workroom. A proportion of 10 parts in 100 can be borne with impunity by men and animals. More than this may give rise to serious symptoms. Hirt quotes from Castan (Gazette hebdom., April 7, 1871) a case of poisoning by the inhalation of this gas in a man who worked at an ice-machine and was exposed to the influence of the gas five or ten minutes. There were symptoms of suffocation, great dyspnœa, burning in the throat, spasm of the glottis, and vomiting of serous matters. When the physician arrived he was in a state of exhaustion, with pallid face, profuse sweat of an ammoniacal odor, pulse small and frequent, temperature normal, mouth and pharynx bright red, and auscultation and percussion gave normal results. He was treated with lemonade and sinapisms, and fully recovered.

Soda factories send forth some chlorine gas, but mostly in composition with hydrogen, as hydrochloric acid. If the apparatus is imperfect, and any of this gas is allowed to escape, the workmen suffer considerably. They are anæmic, emaciated, weak, and often have hot, dry skins, dyspnœa, and bronchial catarrh. The pulse is small and about normal in frequency, but the gastric region may be tympanitic, and often painful and tender to pressure. Diarrhœa is common, the urine is often scanty and high-colored, and there is a tendency to vomiting of yellowish mucus after meals. Hirt attributes the diarrhœa, which is so common in soda-makers, to the immense quantity of water they drink, which always contains acid and is decidedly sour to the taste. The vapors sometimes cause fugitive erythematous eruptions on the covered as well as the exposed parts of the skin. According to Layet, the teeth become soft and translucent, owing to the dissolution of the calcareous particles, and are very apt to break off at the neck, leaving a stump, which gradually grows black.

The emanations given off during the manufacture of the *sulphate of quinine* produce cutaneous eruptions in certain persons. There is some discrepancy in the accounts of the disease given by different observers. According to Hirt, the eruption appears on the parts of the body not protected by clothing, while Proust says it shows itself on the forearms, face, and the internal surface of the thighs and genitals. Its development in the latter locality looks as if it were due to local irritation, the poison

being carried to the parts by the hand. Layet claims that it covers the whole body. It is of an eczematous character, while the eruption which occasionally follows the internal administration of the drug is erythematous. Hirt and Layet state that the disease is accompanied by a fever lasting from ten to fourteen days; but Proust, who made a special study of the subject, has never observed any febrile action. The disease attacks about ten per cent. of the workmen, and they are very liable to a relapse. In fact, instead of being gradually acclimated to the poison, they become more and more susceptible after every attack. It is believed by the workmen that only blondes are affected, brunettes escaping entirely. This statement is ridiculed by Proust, who, however, says that the disease attacks by preference lymphatic persons, and very rarely those who are thin and nervous. In a case observed by Potain, quoted by Proust, the eruption covered the face, but ceased abruptly on the forehead at a line exactly corresponding with the border of the cap. This would seem to indicate that, occasionally at least, the eruption is due to external irritation, and not to the introduction of the drug into the system through the lungs. I have had no opportunity of observing the affection myself, but I have received the following statement from Dr. J. F. Weightman, of Philadelphia, who has had ample opportunity for investigation in the chemical manufactory of Powers & Weightman: "1st. *Only new workmen are affected*, the first symptoms appearing in about three months. *The majority are only affected once*, while others have two or three attacks. Some cannot become accustomed to it. It is exceedingly rare for any one to have it if working in the dry materials. The vapor from boiling solutions seems to be the chief cause. Some cannot work in cinchonia, though able to stand the other alkaloids. 2d. About 90 per cent. are more or less affected. 3d. Begins with intense itching of the skin on parts exposed, and sometimes extends to other parts. The itching is followed by an eruption, which finally develops into eczematous vesicles, which soon burst and form crusts. At this time the parts affected become very much swollen, although not invariably. The swelling is sometimes so great as to make the skin crack. *If there is much swelling the fever is high.* Light complexions are more easily affected than dark." There is a discrepancy, so marked as to be irreconcilable, between Dr. Weightman's statement that "the majority are only affected once," and Hirt's assertion that "one attack of the disease increases the predisposition to it, so that older workmen suffer from it much oftener and more severely than the young." On most other points all observers are agreed, and it will be noticed that Weightman testifies to the occurrence of fever, which Proust doubts. On the question whether the quinine is eliminated from the system through the skin, and in this way gives rise to the eruption, the evidence is still very conflicting. The disease rapidly disappears when work is stopped, and as it only attacks certain persons, and them only once, it would be useless to take precautions against it, or, taking the other view, as it seems to be clearly due to an idiosyncrasy, which increases in susceptibility on continued exposure, persons who are un-

usually liable to it should not follow the trade that necessitates such exposure.

In the manufacture of *potassium bichromate*, vapors are disengaged which have a very peculiar effect upon the nasal mucous membrane of the workmen. A catarrh comes on, with great pricking and sneezing, and the caustic properties of the bichromate having destroyed the superficial portion of the membrane, some of it is brought away with every sneeze. This process, after a short time, results in actual perforation of the nasal septum, without, however, any loss of smell and without pain—often, indeed, without the knowledge of the patient. The ulcerated surfaces heal rapidly when the cause of irritation is removed, but the disease recurs on exposure. Its course is sometimes astonishingly rapid. Hirt saw in Glasgow a thirteen-year old boy, who had worked in the shop only twelve days, and already had his septum perforated. Persons who are in the habit of using tobacco, and particularly snuff, are said to be exempt from the disease.

Wherever the skin is abraded, ulcers form, which spread rapidly, eating even into the muscular tissue, and are very slow to heal. The best treatment for them, according to Parkes, is washing the skin with subacetate of lead.

This peculiar action of potassium bichromate begins at that point in the manufacture when the neutral chromate is boiled with sulphuric acid to form the bichromate. It is therefore still an open question whether the effects produced are due to free chromic acid in the vapors evolved, or to the bichromate in the form of vapor, or in solution, or in powder suspended in the air.

Workmen who are exposed to these fumes should have all abrasions of the skin carefully protected, and as the mucous membrane of the mouth is not usually affected, it suffices to keep a respirator over the nose, either a wire one containing a piece of wet sponge, or a simple piece of wet muslin.

b. *Occupations that expose persons to the inhalation of* POISONOUS *vapors and gases.*

The occupations considered under this heading are those in which the workmen inhale more or less of *carburetted* and *sulphuretted hydrogen*, *mercurial*, *zinc*, *arsenical*, and *phosphorous* fumes, *carbon bisulphide*, *aniline*, *turpentine*, and *benzine*.

These substances are introduced into the body in other ways than by inhalation. Where the poisonous stuff is handled by the workmen, it may be absorbed through the skin, and the metallic poisons are undoubtedly often swallowed with the food or saliva, or may possibly be taken up from abraded surfaces. A peculiarity of these poisonous vapors is that, while they almost all have a decidedly disagreeable odor—some of them, in fact, an extremely disgusting one—they are not irritating, and, as far as any local effect on the lungs is concerned, may be breathed with impunity.

Gasmen are liable to inhale carburetted and sulphuretted hydrogen, when there is a leak in the apparatus. In a concentrated form these gases are very poisonous, but it is rare for workmen in gas-works to be at all injured by them. According to Petersen (Copenhagen) among the workmen in the purifying-rooms, where sulphuretted hydrogen exists in such quantity as to render the atmosphere almost intolerable, bronchitis is unknown. It is a common belief among the people that the air of gas-works is beneficial in cases of whooping-cough, and the workmen have been said to be remarkably exempt from attacks of epidemic disease. There is no statistical proof of either of these statements, and, on the contrary, Hirt states that when the cholera visited Breslau, in 1866, many of the workmen employed in gas-works had it.

These workmen are exposed to sudden variations of temperature in attending the retorts, and are very subject to rheumatism, which most frequently takes the form of sciatica. The profuse sweating caused by the high temperature brings out eruptions of the skin, generally of a papulo-pustular character, resembling the varioloform acne of Bazin (Layet). As much of the luting is done with lead, cases of poisoning by this metal are occasionally found among them.

Gilding used to be one of the most dangerous of trades, but the condition of the workmen has of late been much bettered. Most of the gilding in this country is done by electricity, but, as the gold by this means is deposited in a crystallized form, it is liable to crack off, and the metal beneath becoming oxidized, the rest is loosened and falls away in patches, so that the operation has to be repeated. For this reason, the old method of fire-gilding is still largely adhered to in Europe. In this operation a gold amalgam is formed and spread over the surface to be gilded, and the mercury driven off by heat, leaving a firm, even, close covering of gold, which is exceedingly durable and only disappears by actual attrition. The work was formerly performed in open vessels, and no attempt being made to confine the mercurial fumes, cases of poisoning were common. Now, however, the dangerous steps of the operation are conducted in closed boxes, with hardly any risk to the artisan.

Mirror-makers are also liable to mercurial poisoning. Both men and women are employed at this work, and they spread the mercury with a flannel rubber over the sheets of tin-foil already laid upon the glass. The inhalation of mercurial vapors can hardly be avoided under these circumstances, when it is considered that this metal is volatilized to some extent, at a temperature considerably below that of the human body. The vapors are heavy, and Pappenheim found that in 144 hours they only rose to a height of 37 centimètres from a vessel placed on the floor. In a workroom, however, where the constant motions of the artisans cause conflicting currents and eddies in the atmosphere, the vapors are quickly disseminated through the room.

The workmen who have been for some time engaged at the trade almost all show the mercurial cachexia. They suffer frequently from deep ulcers of the buccal and nasal mucous membrane, swelling of the tonsils

and cervical glands, periostoses of the tibia, rarely of the femur and skull, with violent osteocopic pains. Sometimes the back, breast, and hairy scalp are the seat of macular, papular, or squamous eruptions. They are especially liable to phthisis. Kussmaul's investigations showed that of 56 persons who died in Erlangen, and had been poisoned with mercury, 71 per cent. died of phthisis, while of the total deaths in the same place only 22 per cent. were due to phthisis.

Women are much more susceptible to the influence of mercurial vapors than men, and those who are poisoned abort frequently, and even the children that are born to them are apt to be weak, sickly things, and die early.

Many methods have been proposed of preventing the evil results above described. Crookes has claimed that the addition of one-half of one per cent. of sodium prevents the evaporation of the mercury, without injuring the amalgam. Hirt proposes to expose sulphur in the workrooms to convert the mercurial vapors into cinnabar. Iodine has been suggested with a view of forming the iodide of mercury. The best results, however, have been attained in the mirror-works at Saint Gobain by the adoption of Meyer's suggestion, viz., to sprinkle the floors of the workrooms with ammonia. He says, in a report read before the French Academy of Sciences, that "it is sufficient to sprinkle every evening, after work is over, half a litre of commercial aqua ammonia on the floor of the workroom. The penetrating odor of the gas renders the air of the room less suffocating and less oppressive to the workmen. Since 1868 I have not seen a single new hand affected by mercurial poisoning, while previously the influence of the poison was felt by men who had worked at the trade less than six months. As for the older workmen, who had been affected with mercurial tremor before, the attacks, in spite of their continuance at their work, have become less frequent and less grave. It is better to sprinkle the ammonia in the shop in the evening than in the morning: the preservative action is greater, the free ammoniacal gas spreads more uniformly through the rooms during the interruption of labor."

In these same works it has for some time been the practice for the workmen to shorten the hours of labor, working only from six o'clock till noon, and only on two or three days a week. The windows of the shops are kept wide open, and the flannel rubbers are attached to the end of sticks 1 mètre 20 centimètres long.

Workmen should be obliged to keep themselves scrupulously clean, and should not be allowed to eat their meals in the shop, or with dirty hands.

The only radical relief, however, is to be obtained by giving up mercury altogether in the manufacture of mirrors. The coating of the backs of mirrors with silver has been proved to be practicable, and this method is now adopted to a large extent. When it has become universal, the occupation of the mirror-maker will be added to the already long list of trades that have ceased to be dangerous.

Brass-founders are liable to a peculiar disease called "brass-founder's

ague." It has been generally attributed to the fumes of zinc, but Hirt considers it to be produced by the mingled fumes of zinc and copper, because it occurs seldom, if ever, in workmen who are exposed to zinc fumes alone, *e. g.*, zinc-smelters. Attention was first called to it by Blandet in 1845, and it was first seen by Greenhow in 1858. Two cases have been observed by Hirt, who describes the symptoms as follows: Some hours after inhaling the metallic fumes, a peculiar feeling of discomfort pervades the system, a feeling of weakness and exhaustion, so that the patient has to stop work. Muscular pains are felt in the upper limbs sometimes, but more often in the lower, and they may be excessive. The pulse is quiet and the respiration is not quickened. Soon after the sick man has taken to his bed, a chill comes on and lasts from fifteen to twenty minutes. The pulse is rapid, rising perhaps in an hour to 100 or 120. With all this there is a distressing cough, with soreness of the chest; also frontal headache, often so severe as to be almost intolerable. The attack culminates in from three to six hours. A profuse perspiration breaks out, the symptoms decrease in severity, and the patient falls into a deep sleep which lasts several hours; the pulse becomes normal, the cough disappears, and only slight headache and debility remain for a short time afterward. The prognosis is always favorable, and recovery is complete in from twenty-four to forty-eight hours. The disease often recurs in the same person, and there seems to be no way of preventing it, although experienced founders on melting-days drink great quantities of milk as a prophylactic.

Match-makers inhale the emanations of phosphorus. This substance is formed into a paste with chlorate or nitrate of potash, and the ends of the matches dipped into the mixture. Besides the danger of explosion connected with this manufacture, the workmen are poisoned by the fumes of the phosphorus. The employés in such factories are largely women and children, and the poisoning generally assumes a chronic form. Almost all of them suffer from loss of appetite, and are pale and badly nourished. Gastric catarrh is very common. Lung diseases are not rare among them, and generally are of a catarrhal nature, though phthisis is not uncommon. There is a certain degree of acclimatization in those who work long at the trade, and phthisis occurs oftenest among the beginners. Many of the women complain of severe muscular pains in the arms and wrists, especially the right one. It has been asserted that pregnant women were apt to abort, but evidence is lacking to substantiate this point. Tardieu met one manufacturer who was very positive in the statement that the fumes of phosphorus dulled the minds of workmen, and took away their energy and heart for labor. Layet makes a similar assertion.

The chief characteristic disease of workers in phosphorus, however, is necrosis of the jaws. The disease generally comes on four or five years after the person begins work, and in eleven or twelve out of every hundred who are exposed to the fumes. The first symptom is usually toothache; this is followed by pains in the jaw, swelling and tenderness of the gums, enlarged glands, etc. An abscess forms, which discharges very

fetid pus, and on the subsidence of the more acute symptoms the bone is found to be necrosed. The disease is always chronic in the upper jaw, but in the lower it is sometimes acute and attended with a high fever. The lower jaw is more frequently attacked than the upper in the ratio of five to three (Hirt). Operations for the removal of the dead bone are generally very successful in their results. Billroth, out of twenty-three cases, cured twenty, and the remarkable case operated on by Dr. James R. Wood is familiar to every American physician. Of neglected cases, from 35 to 38 per cent. die.

The cause of this necrosis has been a subject of discussion since Lorinser, of Vienna, first called attention to it in 1845, and has not yet been satisfactorily determined. It was at first supposed that only those operatives who had decayed teeth suffered, and that the noxious vapor found its way to the interior of the tooth, and thence to the jaw, or that in some cases it reached the bone through the cavity left by the extraction of a tooth, but several observers (Strohl, Blandin, Gubler and Lailler, J. B. Harrison) have recorded cases of necrosis in persons whose teeth were perfectly sound. It is, however, undoubtedly the rule that the disease occurs in persons with carious teeth. It is probable that the active agent is phosphorus in substance, and not oxidized in the form of phosphoric acid, as, if the latter were the case, the teeth would be rendered friable and translucent, which they are not. That the emanations consist of the uncombined phosphorus is also probable from the fact that the workmen, after leaving the shop in the evening, have for a little while a phosphorescent breath.

The careful and extended experiments of Wegner seem to show that the disease begins as a periostitis, probably due to a local irritation, and ending in the death of the bone.

The disease is much less common now than it was twenty years ago, and its diminished frequency must be attributed to the greater attention given to the hygiene of the workshop and to the use of amorphous phosphorus in the manufacture of matches, instead of the white form.

Of all the means which have been recommended and tried to better the condition of match-makers, the following are the most approved:

The shops should be spacious and well ventilated. As the phosphorus vapors sink, there should be special means of artificial ventilation by which they can be drawn from below and forced into a lofty chimney. Since Letheby's announcement that one four-thousandth part of turpentine vapor in the atmosphere would prevent the evolution of phosphorus fumes at ordinary temperatures and pressure, vessels containing this fluid are placed upon the floors of the workrooms, with very good results. The English workmen also wear suspended from their necks small tin boxes containing turpentine, so that their noses and mouths are in a measure protected by its vapors. Children should not be allowed in the business, and the teeth of the employés should be examined, and all who have imperfect ones rejected. Astringent mouth-washes may be used with advantage.

The chief measure to be adopted, however, is the substitution of red or amorphous phosphorus for the white. This form of the substance does not give off vapors, and is not poisonous, even when taken internally, so that if its use were general, one of the cheaper ways of committing suicide would be done away with. The red phosphorus requires a little more care and skill for the production of matches of good quality, and so is not quite as advantageous, commercially, as the white form; but it should, nevertheless, be forced into general adoption by legal enactment, if the end cannot be attained in any other way.

In *india rubber* works certain of the workmen are exposed to the vapor of carbon bisulphide, which is used as a solvent for the gum. What is called cold vulcanization is performed by putting the rubber in a mixture of carbon bisulphide and sulphur chloride, and then exposing it in a warm chamber until the former is evaporated. Most of what is known on this subject is due to the labors of Delpech, who first called attention to the serious disorders sometimes found in workmen who worked in rubber factories, and by experiments proved that they were caused by the inhalation of carbon bisulphide.

In the large and spacious factories there is little trouble from this source—at the most, only headaches, slight occasional vertigo, anorexia, occasional vomiting, and drowsiness. These symptoms disappear when the sick person regains the external air. But graver symptoms present themselves in those who work in small, badly ventilated shops, or at home, and the poisoning seems to be particularly frequent in men who make toy-balloons. The attacks may be acute after a few hours of exposure, and attended with violent cephalalgia, visual disturbances, noises in the ears, vertigo, and general debility; or, more commonly, they come on after several months or even years of constant work. At first there are severe headaches, often worse toward evening, soon followed by pains in the limbs, especially the lower ones, and formication or itching at various spots on the body. With this hyperæsthesia comes on an increased intellectual activity, evinced by talkativeness, pleasure in different—often very adventuresome—plans, and sometimes there is actual mental disease. There is some cough, often distressing, with a feeling of oppression in the chest, and a quickened action of the heart. The urine sometimes smells of carbon bisulphide. The sexual appetite is increased in both sexes, and in women the menses are apt to be irregular. This stage of the disorder lasts for weeks, or even months, and is followed gradually by a deep despair and melancholy, dulness, loss of memory, and local anæsthesias. The hands and fingers are so numb that fine work is impossible. The sight is affected, there being a sensation as of a mist before the eyes, and, according to Bergeron and Levi, the cornea is sometimes so insensible that a feather can be drawn across it without causing a wink. The sense of hearing is impaired, and the sexual ability diminishes, and finally is abolished. Death has never been observed in these cases. The sufferers generally give up their occupation, and then a partial or complete restoration to health follows.

The general resemblance between these symptoms and those produced by other anæsthetics is too marked to escape notice. There are differences of detail, but the broad lines of the description apply to cases of chronic chloroform-poisoning.

As the vapor of carbon bisulphide is very much heavier than air, having a specific gravity of 1.27, the evil results of its inhalation may be prevented by having the work with this agent done in a room with a perforated floor, and, if necessary, the downward current of the vapor may be hastened by a fan communicating with a chimney. In large factories, where the rooms are spacious and lofty, and the vessels in use are tight, no precautions against poisoning are necessary.

The *smelters* who are the most exposed to poisonous fumes are those who roast ores containing mercury and arsenic. Both of these metals are volatilized in the process, and conveyed to condensing chambers, whence they are removed after cooling. The workers in *mercury* have sometimes the acute form of poisoning, with a violent stomatitis, but more frequently the disorder is chronic. The gums are somewhat tumefied, and the teeth gradually drop out, one after another, till one sees, as at Almaden and Idria, young men of twenty or thirty with wizened faces, toothless gums, and a horrible breath (Layet). They are often affected with nervous disorders, as insomnia, tremor, acute darting pains in the limbs, muscular spasm, paralysis of the extensors, and intellectual feebleness.

The smelters of *arsenic* ores very rarely suffer from acute poisoning, and even chronic poisoning is not common in well-kept establishments. When it does occur, there is occasional vomiting and diarrhœa, and obstinate nasal catarrh, with rheumatic pains, vertigo, an earthy discoloration of the skin, and general debility, with emaciation. The most characteristic effects are exhibited in the skin, which is the seat of papular, vesicular, or pustular eruptions, the latter often terminating in ulcerations, which present very much the appearance of syphilitic sores, leave indelible cicatrices, and sometimes ineffaceable brownish stains behind them.

These bad results are only to be avoided by the use of carefully constructed furnaces and chambers, and thorough ventilation, with the use of respirators by the workmen in the most dangerous parts of their duty. They should keep their bodies clean, and never eat their meals within the possible range of the poisonous vapors. The use of astringent mouthwashes has been recommended for workers in mercury, and the laborers in the mines of Idria are said to consider tobacco-chewing a valuable precaution against the absorption of the metal.

The manufacturers of *aniline* and of aniline colors are liable to be poisoned by the vapors evolved from this substance. Aniline is an alkaloid of artificial origin, and is obtained by mingling in a retort nitrobenzine, acetic acid, and iron-filings. It is a colorless liquid, with an agreeable vinous odor, and a pungent taste. When it is subjected to the action of arsenic, bichlorid of tin, potassium bichromate, etc., the most beautiful and brilliant dyes are produced, mostly of a reddish hue. Such

are most of the handsome silk dyes of recent discovery, magenta, solferino, fuchsin, etc.

Some of the symptoms which were at first attributed to aniline are due to the inhalation of arsenic and other noxious substances. Those who make fuchsin, which is produced by the reaction between aniline and arsenic acid, exhibit the peculiar arsenical cutaneous eruptions. But besides these symptoms due to other causes, there are some produced by the aniline itself. The workmen are at first seized with severe orbital cephalalgia, nausea, and vomiting. Some are obliged to abandon their work immediately, but in others the symptoms disappear after a week or two, never to come on again, excepting after over-work, or in the heat of summer. Vertigo is frequent, but is relieved by fresh air. Sometimes, however, it is followed by loss of consciousness, and dulness of mind on recovery. Others become semi-comatose, like a man who is dead-drunk, and mutter incoherently. In an hour or so they recover, but have an irresistible desire to sleep. Occasionally genuine epileptiform convulsions are observed. In the long run all these workmen have chloro-anæmia, with diminution of the number of red corpuscles and augmentation of the white. Gastro-intestinal disorders are frequent, with habitual constipation. Many are made impotent

According to Hirt, this substance in poisonous doses paralyzes the sympathetic nervous centres.

The shops where this manufacture is carried on should be roomy, and artificial ventilation be resorted to for the removal of the noxious vapors. The workmen should wear a piece of muslin or sponge over the mouth, wet with a weak alkaline solution. Those who suffer much, or in whom the attacks are renewed, should change their occupation.

Photographers, who use collodion in the preparation of their plates, inhale ether, in small quantity to be sure, but frequently, and often in a confined atmosphere. A certain number of them suffer in consequence from vertigo, and even trembling of the limbs.

The habit of holding the plates between the thumb and index finger produces some thickening and discoloration of the epidermis of the last phalanges, and, especially on the left hand, sometimes causes a certain degree of cutaneous insensitiveness, with dulness of the muscular sense. The hands are always spotted with nitrate of silver marks, and the practice of rubbing them with potassium cyanide to remove these stains has been the cause of some quite serious accidents. The caustic action of the drug, together with the friction, may remove the epidermis, and then there is no hinderance to the absorption of the poison.

The *cleaners* and *scourers* of *cloth* inhale the vapors of benzine and turpentine, which sometimes produce cephalalgia, lassitude, and other nervous disorders. To the vapors of benzine are also attributed a slight trembling of the limbs sometimes noticed, with formication and muscular numbness. Benzine, by dissolving out the fatty matters from the epidermis renders the skin painfully dry and crisp.

c. *Occupations which expose persons to the inhalation of* OFFENSIVE *vapors and gases.*

These occupations all have to do with animal matters, and the offensive odors, being caused by the decomposition of those matters, are mostly due to the presence in the atmosphere of the offensive fatty acids, propionic, butyric, caprylic, caproic, etc., and sulphuretted hydrogen. Although the last named, at all events, is a virulent poison in a pure or nearly pure state, it is generally so much diluted as to be utterly innocuous. All of these offensive vapors and gases are so penetrating and powerful in their odor, and so extremely disagreeable, that a comparatively small quantity in the atmosphere of a room is sufficient to render it intolerable to one who is not accustomed to them. A first exposure excites in most persons merely a feeling of disgust, but in some who are delicately organized, nausea and vomiting may come on, followed by a dull headache lasting for a day or two. More serious symptoms than these are rarely if ever observed, excepting in those exposed to sulphuretted hydrogen in concentrated form, under circumstances hereafter mentioned. Two or three visits to establishments where these vapors are produced acclimatize even the most delicate person rapidly, and a continued exposure to them generally results in an increased vigor and even in robust health for those who had always been sickly.

Persons who suffer from chronic catarrhs and a disposition to lung troubles are often greatly benefited by exposure in oil factories. The workmen suffer less often than the average from cholera, according to Hirt, and there is a smaller mortality among them when attacked. Tanners are also said to be peculiarly exempt from this disease. In 1866, when the cholera visited Breslau, not a single case occurred among the tanners. The same fact was noticed by Parent-Duchâtelet among the workmen at Montfaucon, near Paris, where night-soil was manufactured into poudrette. Hirt speaks of a laborer who for the first time regained perfect health in a sugar refinery, and Eulenberg relates the case of a bone-boiler, who in previous years had been obliged to abandon his proper trade on account of tuberculous tendencies, and after eighteen years of bone-boiling looked healthy and robust.

In short, it may be said of all the occupations under this heading that the workmen engaged in them are strong and healthy, and the duration of their lives is greater than the average. There are certain accidents and disorders of a milder sort to which they are subject, however, and which ought to be mentioned here.

Brewers are said to be sometimes dyspeptic and troubled with congestion of the liver, and Layet states that he has frequently observed among them irritation of the urinary passages, and especially of the bladder.

In the germinating rooms and in the cellars where the beer ferments, as well as in the vats, vast quantities of carbonic acid are generated, and are spread in a layer over the floor. Cases of asphyxia from exposure to this gas occasionally occur among the workmen. They may also be burned by falling into vats full of boiling liquids.

The accidents of a brewery may be avoided by care.

Butchers are generally florid in aspect and robust in person, but their occupation exposes them to cold and wet, and they suffer somewhat from rheumatism. Constipation is common among them, as with all persons who eat much animal food, and hæmorrhoids are not rare. Diseases of the lungs are extremely uncommon.

At the hospital of Saint Louis, in Paris, cutaneous eruptions have been frequently observed in butchers, especially acne sebacea, and they are said to be very liable to furuncles and anthrax. Those who skin calves frequently contract herpes circinnatus on their forearms.

They are occasionally injured in a peculiar way. In cutting meat which hangs from a hook above the head, the knife may slip from the hand and inflict a serious wound. In Bellevue Hospital, in 1868, I saw a young man of nineteen, who in this way had severed the right femoral artery an inch below Poupart's ligament. A similar case was recorded four or five years later in the *Medical Record*, and I have within two years seen two others mentioned in the daily papers, so that such an accident is not to be looked upon as unique. All of these cases died.

Fell-mongers who deal in sheepskins remove the wool before the pelts are sent to the tanner. The skins are soaked in milk of lime, being laid in vats, and frequently hauled and turned so that the lime can act thoroughly on every part. The men who handle the skins, and whose hands are continually subjected to the action of the lime, suffer considerably from its effects. The alkali removes the natural sebaceous secretion from the surface, and the fatty constituents of the epidermis, so that the superficial layers of the skin lose their elasticity and crack open. Fissures are formed at the flexures of the finger-joints, sometimes quite deep ones, and they are so painful and the edges are so rigid as to interfere with extension. It is rare for one of these workmen to be able to open his hand fully. These results may be prevented by the use of india-rubber gloves, but they are too expensive for general use. I would suggest the frequent dipping of the hands in oil, as a possible means of protecting them, or, in order to retain the oil in contact with the hands, the wearing of gloves of common stuff, soaked in oil.

Tanners and *leather-dressers* are, as a rule, healthy men. Those who handle and turn the hides in the vats have sores and fissures on their hands, as before mentioned, and where a mixture of lime and orpiment is used, there may be the characteristic arsenical eruptions. In the manufacture of patent-leather, preparations of lead are often used and may cause lead-poisoning. According to Hirt, fatal cases of poisoning by carbonic acid have occurred, where men entered vats in which gas-lime had been used and had evolved a quantity of that gas. There is also a certain amount of danger from malignant pustule, especially for those who handle skins from oriental countries.

Gut, tripe and *head-cleaners* are wet while at work, but do not seem to suffer in health thereby. *Fat-renderers, lard-refiners, bone-boilers, glue-makers, fertilizer-makers, pork-packers, soap-makers, oil-pressers* and

cheese-makers are exposed to offensive gases, but, so far from suffering in health on that account, appear to be actually benefited.

Scavengers, including those men who clean out receiving-basins and sewers as well as those who empty privy-vaults, are exposed to the inhalation of highly offensive and very poisonous gases, viz., sulphuretted and carburetted hydrogen and carbonic acid. Besides these gases, the air of sewers, cesspools and privy-vaults contains more than a normal amount of nitrogen, a very much diminished proportion of oxygen, some hydrogen and ammonium sulphide. Notwithstanding the offensive nature of their occupation, scavengers are in general a healthy class of men, and the few cases of sickness and death which can be fairly traced to the prosecution of their trade are to be looked upon as accidents, and as rare ones at that.

In cases where laborers are overcome by these mephitic gases, the symptoms are easily divided into two classes: those of asphyxia, due to a preponderance of carbonic acid, and those of blood-poisoning caused by sulphuretted hydrogen. In the former case the workman is suddenly prostrated on entering the vault, and is removed in a state of unconsciousness, with blue lips, livid features, and occasionally slight convulsions. In poisoning by sulphuretted hydrogen, there is giddiness and faintness, with perhaps nausea and vomiting, sometimes followed by a low fever, attended with great depression of spirits, slow pulse, yellowness of the conjunctiva about the fifth day, and sleeplessness. This disease, called mephitic fever, lasts two or three weeks, and usually ends in recovery. As the gases are generally combined in sufficient quantity for each to produce its own effect, there is generally a complication of symptoms, in which, however, the essential features of asphyxia and of blood-poisoning can usually be distinguished from each other.

According to Hirt, workmen who are exposed to an atmosphere containing sulphuretted hydrogen can protect themselves to some extent against its poisonous effect by drinking large quantities of milk. He says that such as do this regularly suffer less from poisoning than others.

With the improved methods of emptying privy-vaults by pneumatic apparatus, the old dangers attending the work of the scavenger have nearly disappeared.

Sugar-refiners are somewhat subject to bronchial and gastric catarrhs on account of the elevated temperature and the sudden variations of temperature to which they are exposed. They also suffer to some extent from eczematous and furuncular eruptions caused by the impurities in the sugar and molasses which they handle.

Fullers clean the new cloth by dipping it in water containing fuller's earth or soda and decomposing urine. The offensive smell produces no bad result, but the hands of the workmen are affected by a skin disease. Small, numerous, crowded vesicles appear, itch dreadfully, are scratched and leave excoriations, which ulcerate. Every exposure increases the evil, the skin gradually loses its characteristics, there is even considerable loss of substance, the sense of touch is blunted, and there is a feeling of

numbness in the hands, with severe pains. No treatment arrests or heals the disease (Hirt).

Hostlers, cow-boys and dog-fanciers are exposed to animal effluvia, but do not appear to suffer in health thereby. The chief dangers attached to these trades are those of being injured by ugly animals and of catching a contagious disease (glanders, farcy, hydrophobia).

Rag-pickers live under the most unsanitary conditions possible. They are exceedingly poor, and huddle together in small rooms, surrounded by filth, and generally keeping the offensive matters which they collect in the streets in the same room with themselves. Their bags are filled with rags, bits of dirty paper, broken glass and bottles, bones, scraps of meat, etc., and exhale an indescribably horrible odor. Ollivier (d'Angers) having been called to visit a rag-picker's den where were collected bones and scraps of every sort, was attacked some hours later with nausea, very fetid fluid evacuations, cold sweats, and syncope, genuine symptoms of septic poisoning which gradually disappeared (Layet). Although I have never known so serious a result as the above, I have seen nausea produced by a visit to one of these rooms, in one who was not accustomed to such sights and smells.

During the prevalence of epidemic diseases, rag-pickers are extremely liable to take them, especially cholera and typhoid fever. Their exposure in all kinds of weather also renders them subject to rheumatism and pneumonia.

The pressure of the bag in which they make their collections produces characteristic marks on the back and loins, according to Vernois, consisting of three serous bursæ with thickening of the skin, forming as it were the three angles of an isosceles triangle apex downward; the lower angle corresponding with the upper part of the sacrum, and the other two situated about two centimètres above the posterior superior spine of the ilium on either side.

These people are so poor, so degraded, and so set in their way of life, that any attempt to improve their sanitary condition is almost hopeless.

B.—Dust.

There are many occupations in which enormous quantities of dust are evolved and float in the air of the workroom, so that the artisans inhale it with every breath. The dust which thus enters the lungs may act in either of two ways; it may set up an irritation in the mucous membrane or parenchyma of the organs—in other words, produce a mere local effect, with constitutional symptoms perhaps as the ultimate result; or it may be taken up by the blood or lymphatics and produce acute or chronic poisoning. In the latter event the local effect is often slight. Accordingly it is proper to treat separately of the inhalation of *irritating* and of *poisonous* dust.

a. *Occupations that expose persons to the inhalation of* IRRITATING *dust.*

No atmosphere is free from dust, unless it be on the summits of high mountains. Upon the common level, where living things must pass their existence, the air is full of impurities, organic and inorganic, and every animal draws millions of particles into his lungs with every inspiration. But although certain diseases are communicated in this manner, and many others perhaps produced whose origin is at present obscure, it is probable that the moisture which constantly covers the mucous surfaces protects us against any ulterior injury from the inhalation of the amount of dust ordinarily found in the air. But when the confined atmosphere of a room is artificially loaded with foreign particles, actual disease is frequently produced. The first effect of an abnormal quantity of dust in the inhaled air is cough, with increased mucous secretion and expectoration. This gradually develops into a chronic bronchial catarrh, which in time has its usual sequences of bronchiectasis and emphysema. This catarrh less often affects the trachea, and very rarely the larynx. Of the different kinds of dust, that of vegetable origin has the most irritating local effect, and is oftenest followed by catarrh; next comes the metallic dust; then that of animal origin, while mineral dust is in this respect the least dangerous (Hirt).

But dust not only irritates the respiratory surface, but actually penetrates the substance of the lung and causes grave changes there. Exactly how this penetration is accomplished is still a matter of speculation, as the process can only be inferred from the results of observation and experiment, and the parts cannot be examined while it is going on. Dr. Knauff confined animals in a box into which the particles from a sooty lamp passed; the animals were well fed and healthy; the charcoal passed into the lungs, and was got rid of by expectoration in the form of pigment-cells. When Knauff inhaled particles of ultramarine for only ten minutes, and examined his sputa, he found cells with blue particles in their interior. In a cat, charcoal particles penetrated in three days from the lungs into the lymphatic glands and to the pleura. Dr. Greenhow has also pointed out how easily small floating particles enter the air-cells and encroach on the alveoli, and pass into the interior of ciliated epithelium. Villaret confined rabbits in a smoky atmosphere, and proved the existence of fine particles of carbon in the bronchi (Parkes).

Sigerson found in the atmosphere of shops where metal was worked a black dust containing particles of iron in small, jagged pieces, and also as small spheres, one two-thousandth of an inch in diameter. The Germans, with their usual inquisitiveness, have tried to discover how these particles penetrate the tissues. Thus, Hirt says that not only sharp-cornered, hard, pointed molecules enter the lungs, but also roundish, blunt ones, which do not irritate. So that we must suppose the tissues are not pierced, but pressed apart (what is the difference?) to allow the passage of the dust. and then resume their natural relations. Rindfleisch, with regard to coal-dust, maintains that the particles cling to the alveolar walls, and gradu-

ally pass through, follow the stream of extra-vascular fluids, meeting on the way cells which are able to take them up into their substance, *e. g.*, connective-tissue corpuscles, amœboid wandering cells of the lung connective tissue, and all that are not thus taken up pass on to the roots of the lung and the bronchial glands (Hirt).

But whatever the method by which the particles reach the interior of the cells and other tissues of the lungs, their presence is a constant source of irritation, and results in chronic inflammatory processes, which produce induration of the lung, local abscesses and ulcerations, and phthisis, occasionally followed by true tuberculosis. The liability to this disease is greatest in those who work in a constrained attitude, with contracted chest and body bent forward, and who sit all day at their task. When frequent changes of posture and plenty of free muscular exercise are possible, the tendency to phthisis is much diminished.

That phthisis is much more common among dust-workers than among others belonging to the same social stratum has been proved by carefully compiled statistics. Thus, among the workmen in the Aller-heiligen Hospital, at Breslau, from 1859 to 1869, and in the Julius Hospital, at Würzburg, from 1859 to 1865, there were 12,647 who worked at dusty occupations, of whom 1,936, *i. e.*, 15.3 per cent., had phthisis. Out of 1,110 who had not been exposed to the inhalation of dust, 153, *i. e.*, 13.7 per cent., had phthisis. Hirt's own investigations in the above hospitals include 1,076 deaths. Among these were 763 dust-workers, of whom 365, *i. e.*, 47.8 per. cent., died of phthisis, while in trades not involving an exposure to dust only 38.6 per cent., died of phthisis.

In certain trades the proportion of phthisical cases is much greater than that just given above, where many occupations are doubtless included in the estimate, in which the dust produces hardly any appreciable effect. Among needle-polishers, for example, the proportion of cases of phthisis to the total number of sick reaches the astonishing figure of 69.6 per cent., and among flint-workers the frightful ratio of 80 per cent. There is a great difference in the effect of different kinds of dust in this respect, as will be seen from the following table, taken from Hirt:

PERCENTAGE OF CASES OF PHTHISIS IN TOTAL NUMBER OF SICK AMONG WORKMEN EXPOSED TO THE INHALATION OF DUST.

		METALLIC.			
Needle-polishers	69.6	Compositors	36.9	Varnishers	25.
File-cutters	62.2	Watchmakers	36.5	Painters	24.5
Lithographers	48.5	Type-founders	34.9	Printers	21.6
Sieve-makers	42.1	Engravers	26.3	Beltmakers	19.7
Grinders	40.4	Dyers	25.	Tinkers	14.1
		MINERAL.			
Flint-workers	80.	Porcelain-makers	16.	Masons	12.9
Grindstone-makers	40.	Potters	14.7	Diamond-cutters	9.
Stonecutters	36.4	Carpenters	14.4	Cement-makers	8–10
Plasterers	19.				

VEGETABLE.

Cigar-makers........36.9	Millers..............10.9	Chimney-sweeps...... 6.5
Weavers.............25.	Bakers.............. 7.	Coal-miners.......... 0.8
Ropemakers.........18.9		

ANIMAL.

Brushmakers........49.1	Fell-mongers........23.2	Hatters.............15.5
Hair-workers........32.1	Turners............16.2	Button-makers......15.
Upholsterers.........25.9		

IXED.

Glass-cutters..........35.	Glass-makers........17.8	Day-laborers........15.1

NO DUST.

Shoemakers.........18.7	Coopers.............10.1	Tanners............ 9.2
Brewers............11.2	Glovers..............10.	Butchers............ 7.9

The form of phthisis caused by the continued inhalation of dust, although it resembles in its symptoms the disease known as phthisis pulmonalis, differs from it in two important particulars, viz., it is not hereditary, and, if the dangerous occupation be abandoned, recovery often takes place, even when the disease is far advanced. Oldendorff mentions having seen among the grinders in the Düsseldorf district old men of sixty or seventy, who were perfectly sound, with the exception of slight shortness of breath, and who, thirty years or more before, had their lungs so seriously affected while prosecuting their trade as grinders, that they were given up as hopeless, and had only escaped certain death by quitting their occupation.

Hirt is of the opinion that, besides catarrhal affections and phthisis, the inhalation of dust may also produce acute pneumonia. He does not furnish statistics to support this view, but gives the following singular case which came under his own observation.

A. H., thirty-one years of age, cotton-weaver, of sound parentage, was healthy up to his twelfth year. In his thirteenth year he left school, and began to learn the weaver's trade in his father's small factory of three looms. Without previous catarrh or other warning, after four weeks' work, he was attacked with pneumonia on the left side. After recovering he returned to work, and in a few months had a second attack, and in his nineteenth year a third. During his three years of military service he remained well. On returning to work, after six weeks, he had a fourth attack, and in his twenty-ninth year a fifth. In October, 1868, Hirt attended him in his sixth attack, which this time invaded the right side, all the others having been on the left. He recovered perfectly, and was otherwise sound. There were no cotton-fibres discoverable in the expectoration.

This case seems hardly enough to form a decided opinion from, and the disease is much more likely to have been due to some other cause than the inhalation of dust, for it is difficult to understand how a parenchymatous inflammation could be produced without previous catarrh by a kind of dust that can only act as a mechanical irritant.

Workmen who are exposed to an atmosphere containing alkaline dust,

as of lime and soda, are likely to have pterygium. In this connection I may state that Dr. R. C. Van Wyck, late of Denver, Colorado, informs me that this disease of the conjunctiva is very common in that locality where the air is often filled with dust fron the alkaline plains.

Zenker has named and classified the diseases caused by the inhalation of dust under the general name of *pneumonoconiosis* (πνεύμων, *a lung*, and κόνις, *dust*), as follows: *Anthracosis* (ἄνθραξ, *coal*), due to coal-dust; *siderosis* (σίδηρος, *iron*), due to metallic dust; *chalicosis* (χάλιξ, *gravel or pebbles*), due to mineral dust; *tabacosis*, due to tobacco-dust, and *byssinosis* (βύσσος, *cotton*), due to cotton-fibre and dust.

There are few occupations in which workmen are exposed to *metallic* dust alone. It is usually combined with other matters, and especially with silicious particles. The only metal which has been actually found in the lungs is iron, in the form of the sesquioxide (Zenker) or the magnetic oxide (Merkel). When these deposits occur in the lungs, induration and ulceration take place, and the patient dies of phthisis.

Zenker's first case was that of a woman of 31, who died in the hospital at Nuremberg in 1864. She had worked for many years in a small, close room, applying a fine, dry, red powder (English red, ferric sesquioxide) to a transparent paper until it was thoroughly permeated. The lungs were of a vivid brick red, and presented the same appearance on section. Analysis showed the presence of ferric oxide in great quantity (22 grammes in both lungs). The second case was altogether similar. Merkel's case is unique. It was that of a man who worked at cleaning the surface of iron that had become oxidized. He scrubbed it with sand, and necessarily inhaled much of it in the form of dust. His expectoration was grayish-black, and was found to contain small grains of the magnetic oxide of iron. The lungs were indurated, with cavities at the apices, and 100 grammes of lung-tissue furnished 0.885 grammes of iron.

Bronzers of wood, plaster, etc., sprinkle the bronze powder upon a surface previously covered with varnish or glue, and afterward polish it. In this operation they inhale dust to some extent, but not in a sufficient amount to cause more than slight catarrh. After the bronzing is done, the surface is colored by using a sulphide so as to produce a thin layer of the sulphide of copper. For black bronze, the sulphide of arsenic is used, and for green bronze, a mixture of ammoniacal salts with arsenic or copper. These operations give rise to noxious vapors and occasional cases of arsenical poisoning.

File-cutters work with hammer and cold chisel, holding the blank on the anvil by a strap passing under the feet, and putting sand or other dust on the anvil to keep the iron from slipping. They have to bend over their work, keep the eyes keenly fixed upon it, are exposed to metallic and mineral dust, and, in making coarse files, to great bodily exertion, their hammers often weighing as much as six pounds. Phthisis is very common among them. The work requires a very delicate touch and a constant variation of the force of the blow, because it is impossible to make all the

blanks of the same degree of hardness. For this reason the attempts which have been made to substitute machines for hand-labor have been so far without success.

Grinders, needle-makers, pin-pointers, cutlers, etc., inhale a mixture of metallic and mineral dust, and these occupations are among the most perilous that can be followed. The various steel and iron implements are pressed upon grindstones revolving at the rate of 2,000 or 3,000 times a minute, and the operation often requires a considerable expenditure of physical strength and a very constrained position of the body. The danger of the occupation varies with the amount of dust inhaled and the attitude of the workman. It reaches its height in the grinding of forks and needles, which must be done on dry stones, to avoid the possibility of rust. Razors, scissors, table-knives, etc., are ground at first on dry stones and then on wet ones, and the peril of the workmen is proportionately diminished. Finally, saws and all the coarser implements are ground on wet stones, and the danger from the inhalation of dust is at its minimum.

The form of phthisis produced by the inhalation of metallic and silicious dust, called "grinder's asthma," is divided by the French writers into three stages: the first corresponding to the simple presence of the foreign bodies in the lungs, the second to the congestion and induration which follow, and the third to the formation of cavities. This reminds one of the former three stages of phthisis, a division also of French origin. The symptoms of these stages are so mingled, however, that there is really no practical advantage in separating them in sets with rigid lines of demarcation.

The disease comes on very gradually, like the more slowly developed forms of phthisis pulmonalis, and its duration may be extended over four or five years. It begins with the cough of irritation, dry and hacking at first, with very scanty expectoration, whitish and stringy in character; there is no hæmoptysis, but sometimes nausea and vomiting in the morning. Auscultation at this time reveals puerile respiration, with occasional slight râles. The expectoration gradually increases in amount and becomes reddish, and soon after this tinge appears there may be hæmoptysis. There is dyspnœa on slight exertion, and dulness over the whole chest, with weak respiration and mucous râles. There is no fever, and the appetite and strength are still good. If work is abandoned at this time, recovery is not only possible, but in most cases probable. If work is continued, the lung-tissue begins to break down, and cavities form near the apices. Expectoration is very profuse, and there may be severe hemorrhages. There is general dulness on percussion, and the last traces of vesicular respiration give way to sibilant, large mucous and cavernous râles. Fever is continuous, with evening exacerbations, night-sweats, emaciation, insomnia, and great dyspnœa, soon followed by death.

The lungs of such patients, on section, are found to be studded with small, black knots, from the size of a pin's head to that of a pea. The exact nature and composition of these bodies has not been determined (Hirt), but they are probably very similar to the concretions found in the

lungs of sandstone-workers and glass-cutters, which consist mainly of silica. The bodies in question, however, are likely to contain a considerable proportion of iron, as the dust caused by the labor of grinders, according to Schütte, is three parts iron to two parts stone. There are generally adhesions between the lungs and thorax, and cavities, sometimes of large size. The bronchial glands are enlarged and often degenerated.

Grinders of steel are also liable to injury from flying particles of metal, which are intensely heated by friction and scatter in the form of sparks, producing occasionally severe burns of the cornea.

Grindstones sometimes burst, when driven at a very high velocity, and the fragments crush everything in their path as they fly off at a tangent. Every workman runs a certain amount of risk from this source.

Those who work at wet grinding, while they are relieved from the danger of dust, are covered with the spatterings from the stone, consisting of mud and water, and so are kept constantly wet and cold. They are more liable than the others to rheumatism, pneumonia and bronchitis of an acute form, due to such exposure.

The mortality among grinders is very great. Among needle-grinders in Derbyshire, according to Holland, the average age at death in twelve cases was only thirty years and eight months. According to Fox Favell, they die at or below their thirty-fifth year, and Dr. Schütte gives the average age at death of nine as thirty-one years.

Much ingenuity and labor have been spent in attempts to protect workmen from the dust caused by grinding. All of the methods adopted divide themselves naturally into three classes: those which aim to prevent the dust with which the air is filled from entering the respiratory passages; those which aim to remove the dust from the room before it reaches the workmen; and those which aim to prevent the formation of dust.

In the first class fall the various respirators, whose purpose is to admit the air, but keep out the dust. Many different varieties have been invented (Gosse's, Eulenberg's, Durwell's, Leffrey's, Tyndall's, Poirel's, Camus's, etc.). Some of them simply cover the mouth, others the mouth and nose, and others still the whole face, like a mask. The filtering substance may be a thin layer of sponge, muslin, wadding, felt, or linen, kept in position by a framework of wire-gauze, and may be either wet or dry. Respirators have never been popular with artisans, and have fallen largely into disuse, as they are hot, and moreover, interfere to some extent with respiration.

The third class mentioned above includes the substitution of wet grinding for dry. This cannot be done in all kinds of work, and the really practical methods of protecting the workmen fall under the second class.

It was at first thought that if the stone were surrounded by a wooden covering, leaving an opening barely sufficient for the use of the workman, and this wooden box were connected by a shaft with the external air, the particles of stone and metal would be carried out by the draught, but although something was accomplished in this way, success was far from

being attained. A great advance was made in the use of the mechanical fan. A single fan may withdraw the dust from several stones, the separate shafts from the boxing around the stones uniting to form one. The opening before which the workman sits should be as small as possible, for the smaller it is the more rapid will be the inward current of air, and the more perfect the protection afforded. The opening of the shaft by which the dust is drawn away should not be at the top of the stone, but near the bottom, for otherwise some of the heavier particles falling to the bottom of the box might in time be carried up again by the current created by the whirling stone, and as they came opposite the workman's opening might escape into the outer air. By placing the exit shaft at the bottom this mischance is rendered impossible. Hirt gives the following estimate of the work that can be accomplished by one of these fans: a fan-ventilator, with blades of 0.78 m. diameter, and of a breadth parallel to the axle of 0.40 m., with a central opening of 0.28 m., making from 900 to 1,000 revolutions a minute and requiring an engine of 8 or 10 horse-power, will draw off the dust from 14 grindstones.

Those who do wet grinding should wear waterproof clothing on the parts exposed to the spattering of the stone. Those who do fine work, and whose eyes are therefore exposed to injury, should cover those organs either with plane glasses or spectacles of fine wire-gauze.

The bursting of stones may be due to an original flaw, but has been more frequently attributed to the swelling of the wooden wedges by which the axle is retained in position. The latter cause is more likely to act, of course, in stones that are used for wet grinding. Grindstones should therefore be carefully selected and tested before mounting, and should be set up on iron axles fastened with molten brimstone. In some factories they are surrounded with strong iron framework, which would offer so much obstruction in case of rupture as to materially diminish the damage done.

Needles and pins are now largely made by machinery, and so the most dangerous of all the grinding trades is becoming almost innocuous.

The inhalation of *mineral* dust produces symptoms and lesions like those just described, viz., the ordinary symptoms of pulmonary phthisis, and induration of the lung with cavities and numerous nodules, varying in color from light gray to deep black, with generally a bright, whitish nucleus. The explanations of the nature of these deposits have been various and conflicting. Rokitansky looked upon them as incapsulated tubercle, Förster considered them pigmented thickening of the interstitial connective tissue, Virchow transversely cut bronchioles with thickened adventitia, and Rindfleisch modified tubercle (Hirt). Chemical analysis, however, shows that they are undoubtedly accumulations of mineral dust. Malapert (of Poitiers) found the darker ones to consist mainly of silica, with a little phosphate of lime and iron, while the grayish white ones were made up wholly of silica. Meinel also demonstrated that such lungs contain an immense and disproportionate amount of silicic acid. Thus he found that 30.71 of the ashes of lung-tissue, and 41.08 of the

bronchial glands was silica and sand, while, according to Kussmaul, the normal lung contains from 4.22 to 17.3 of this substance.

The workmen who make *Portland cement* are greatly troubled by the dust caused by shovelling the mass into sacks, after it has been burned and ground. They have a persistent cough, and expectorate little lumps of cement. They find it impossible to continue this part of their labor day after day, and are obliged to take intervals of rest.

Stonecutters work with hammer and chisel, and not only inhale considerable dust, but are liable to injury from the flying chips and occasional sparks from the chisel. Lesions of the cornea are not uncommon among them. The inhalation of dust produces in them frequently the form of phthisis already described. According to Allison, the sandstone-cutters near Edinburgh rarely attain the age of fifty, and almost all die of consumption. It is the common observation of all writers that the cutters of millstones are more affected by their work than any others, of this class. Peacock gives the mean duration of their work at this trade as nine years. Many of them are obliged to give it up earlier.

In the manufacture of *pottery* and *porcelain* the workmen are exposed to several sources of injury. The sifting and mixing of the earth used in the trade, and the grinding away the unevenness on articles already baked, cause a great deal of dust. The flat-pressers, who force the clay into moulds with a great expenditure of muscular strength, are especially affected. So common is emphysema among them, that it is called the "potter's asthma" (Parkes). To the china-scourers the light flint dust is a terrible irritant. Dr. Greenhow states that all sooner or later become asthmatical. The female operatives are pallid and chlorotic, and their infants are almost all scrofulous, with an enormous mortality. At Stoke-upon-Trent, in the Staffordshire pottery district, in 1864, the deaths from respiratory diseases were 9.10 per 1,000 of the population, while among the potters taken separately they were 13.5 per 1,000, a difference of 50 per cent.

The burners are exposed to a temperature of about 104°, and suffer somewhat from sudden changes, which produce acute pulmonary affections, rheumatism, and gastro-intestinal disorders.

The enamels used on the different kinds of porcelain contain lead, and there are occasional instances of saturnine poisoning among the operatives in this branch of the business.

The mixers of the clay are said to be very subject to muscular and articular pains, and to synovitis of the sheaths of the tendons of the fingers.

Lime- and *plaster-burners*, and the workmen in *plaster-mills* are exposed to dust, but do not seem to suffer in health for that reason.

In the manufacture of *glass*, the workmen who grind and powder the silicious material inhale great quantities of very irritating dust, and suffer from constant hacking cough and conjunctivitis. It is rare to find a sound man among them, and they are not able to continue long at the work. According to Hirt, they should not be allowed to labor, at a stretch, more than two or three weeks, and should then work at some-

thing else, or, at any rate, give up this occupation for at least double the working time. In this way, by the use of relays, the health of the men may be sustained.

But the most dangerous work is that of the grinders and polishers of cut-glass. About 35 per cent. of them have chronic pneumonia (phthisis), and their average age at death is variously given at from 30 to 42 years. Putégnat (de Lunéville) has described a peculiar form of gingivitis which he has observed among glass-cutters, and which, he says, attacks 95 out of every 100 workmen. It comes on in about three months after the person begins work, and toward the sixth month is well developed. It attacks by preference the upper jaw, and is accompanied by the same blue line that is found in cases of lead-poisoning. The acid secretion of the gums destroys the enamel of the teeth, which soon become pointed, brittle, and break off close to the alveoli, leaving a permanent stump. The gums remain soft and spongy, and the breath is very fetid. At no time is there any pain or hemorrhage. He supposes it to be caused by malnutrition, bad air, etc. (Tardieu). These symptoms certainly appear suspiciously like those of lead-poisoning, and the suspicion is rendered stronger by the fact that French flint-glass contains about 20 per cent. of lead, and that other symptoms of lead-poisoning are not uncommon in glass-cutters, as colic, constipation, muscular pains, etc. Garrod has noticed the frequency of gout among them, and brings it forward to support his theory of a connection between that disease and saturnine poisoning.

The grinding or etching of glass by the *sand-blast* fills the rooms with a dust composed of particles of sand and glass mingled. The business is a comparatively new one, and the workmen so far do not appear to be injured by it, with the exception of a slight tickling cough when they first begin work. The dust is rather coarse and heavy, and I am inclined to think it does not penetrate very far into the lungs, perhaps even not getting beyond the trachea, whence it is easily expectorated.

In *diamond-cutting* the amount of dust created is small, and yet the occupation is a very injurious one. The "setter" prepares the diamond for the cutter by soldering it on the end of a copper rod with an alloy of 4 parts lead to 1 of tin. He does this with a charcoal fire, and is exposed to great heat, as well as to poisonous gases. The setters suffer from headache, tinnitus aurium, impaired digestion, and irregularity of the bowels. In Coster's factory, at Amsterdam, $73\frac{1}{12}$ per cent. of them were pale and emaciated, 57 per cent. had palpitation, giddiness, præcordial distress, 56 chronic headache, 36 asthma, etc. The use of the solder produces lead-poisoning. Out of 90 examined, 30 showed traces of poisoning. In general they are all sick men, and suffer from lung troubles. Nine per cent. had phthisis.

The *cutters* or *polishers* grind the gems on iron wheels covered with diamond-dust and oil. The dust inhaled by them, though small in quantity, is enough to cause frequent chronic lung troubles. In Coster's factory, 52 per cent. of them were thin and pale, 40 per cent. asthmatic, 33.75 suffered from headaches, etc.

Lithographers inhale some stone-dust while at work, because their face is so near the object on which they are engaged. The slight irritation thus caused would not of itself probably produce disease, but the sedentary life and the constrained attitude, with the shoulders drawn forward, the chest contracted, and frequently the movements of the sternum during respiration seriously interfered with, shorten the life of the lithographer by several years. Many of them die of phthisis, and nearly all suffer somewhat from chronic bronchitis.

The workmen who inhale *vegetable* dust do not as a rule suffer in consequence. The dust of wood, in particular, is so harmless that it seems more appropriate to speak of cabinet-makers and carpenters under another heading, as their attitude while at work has more to do in bringing on disease than the atmosphere they breathe. The dust of the hard woods, as mahogany, rosewood, etc., may cause slight irritation of the larynx and trachea, and a tendency to bronchial catarrh. There are, however, some forms of vegetable dust which produce considerable irritation, either by reason of their composition, as tobacco, or their shape and size, as cotton, flax, or hemp, or their rigidity and insolubility, as charcoal.

Chimney-sweeps were formerly quite subject to an epithelioma of the scrotum, called chimney-sweep's cancer. The exact cause of this affection has never been ascertained. Hirt thinks that soot has some quality, besides that of mere mechanical irritation, which brought on the disease. It is certain that charcoal-powder will not produce it, and it is unknown among colliers. Of late years it has become an exceedingly rare disease, although the trade is still carried on. Hirt furnishes these suggestive figures: in the Brompton cancer hospital, during the twenty years from 1851 to 1871, there were treated 10,756 cases of cancer, of whom 8,680 were women; of the 2,076 male patients, only 162 (7.7 per cent.) had cancer of the genitals, and of these only 9 had chimney-sweep's cancer, all previous to 1860. It has been suggested that this form of epithelioma was caused by the friction of the thighs upon the scrotum during the process of sifting the soot, the sieve being shaken by the operator while in a stooping position, and that the disappearance of the disease is due to the fact that this process, no longer paying, has been given up.

The men who prepare *moulds* for bronze and copper castings sprinkle them with charcoal-dust before the molten metal is run into them. This dust must be very fine and is carefully sifted. During the sifting and when the mould is sprinkled, the air is filled with dust of a very irritating character, which eventually produces in the workmen exposed to it the phenomena of anthracosis. The clinical characters and morbid anatomy of this disease were carefully studied by Tardieu in 1853–'54, and more recently by Proust (1874). They agree in dividing the course of the disease into three well-marked stages. At first, rarely within ten years of the commencement of labor, there is an extreme sense of fatigue, disproportionate to the amount of muscular force expended, which comes on particularly in the latter part of the day, accompanied with a dyspnœa

that increases until the day's work is over, and lasts until late in the evening. This dyspnœa soon becomes habitual and is accompanied by an obstinate cough. Percussion shows general dulness, especially at the apices, with spots of almost complete flatness irregularly situated. The vesicular murmur is diminished in intensity, and at the flat spots disappears. Sometimes there are bronchial râles.

In the second stage, all the symptoms are more pronounced; the face is pale and leaden, the gait feeble. There is constant oppression and sighing respiration, with incessant cough, sometimes spitting of blood, and the expectoration of thick viscid masses containing black powdery lumps. Emaciation sets in, and there are frequently complicating organic affections, as dilatation or hypertrophy of the heart, and mechanical obstruction of the circulation in the liver and other digestive organs, with diarrhœa and œdema of the extremities. The sufferer is now obliged to give up work, or at the most to labor only a fraction of the day.

In the last stage, symptoms of asphyxia come on, which result in death.

The pathognomonic symptom of the malady is the black expectoration, which has been carefully examined by Traube, Robin, and others, and found to contain particles of carbon in the epithelial cells which compose the greater portion of its mass.

The disease is essentially a chronic bronchial catarrh, with resulting emphysema and asthma. Tardieu in his official report upon the subject recommended the use of starch instead of charcoal in the moulds. In Paris this change has been made very generally, and with the best results. If the use of charcoal is adhered to, the workmen must necessarily wear respirators.

Millers inhale the dust of flour and meal in considerable quantity, but it seems to have almost no effect upon the respiratory tract. As an external irritant, however, these substances are very active. A constant exposure to them causes itching, and the scratching that naturally follows brings out various cutaneous eruptions, mostly eczematous in character, though acne and furuncles are extremely common among millers, and so is blepharitis ciliaris. There is one form of skin disease said to be peculiar to millers. It is a papular eruption, changing to more or less confluent vesicles, with violent itching at night. In the morning the symptoms decrease in severity, and the itching disappears without treatment. The disease is not contagious, and appears most commonly on one side of the neck, where it is touched by bags carried on the shoulder. It is said to be due to an acarus, which some have considered to be the larva of the weevil.

Millers are liable to a peculiar kind of accident, from the explosion of fine dry flour when brought in contact with flame. The exact cause of these explosions is still a little obscure, but they seem to depend upon the rapid combustion of the dry flour in a state of extremely fine division, and the formation thereby of gases which being heated expand with explosive force. They generally take place when a light is introduced into the

room where the flour is bolted, and are very destructive in their effects. Two such very disastrous explosions have recently occurred in Minneapolis, Minn., and the great fire in the Barclay Street candy-works, in New York, in 1877, was probably due to a similar cause. Great caution and the use of safety-lamps appear to be the only methods of preventing such explosions.

Cotton, flax, and *hemp operatives* suffer a great deal from dust. The raw material has to be cleaned by beating and carding, and the dust flies out into the air. This dust consists mainly of silicious particles, but there are also fibres of the different materials and woody fragments. Cotton operatives, when they first begin the work, suffer from a dreadful tickling of the throat, causing severe cough with whitish sputa. This cough may be merely the precursor of chronic bronchial catarrh, or it may be followed by severe pains in the chest, great anæmia and debility, emaciation, and occasionally profuse diarrhœa, so that work has to be abandoned. In 1836 Coetsem published a paper in Brussels, describing a form of "pneumonie produite par la poussière de coton." The disease appears in cotton operatives from thirteen to thirty years of age, and may be divided into three stages: In the first there is chronic bronchial catarrh. In the second, frequent respiration and harassing cough, with white, frothy, viscid sputa, like the whipped white of an egg, clinging to the side of the cup. When this is mingled with water, flocculent specks are set free, which are found to be identical with those floating in the air of the workroom. A dull pain is felt in the middle of the breast. The tongue and pharynx are dry, the voice hoarse, appetite gone, bowels regular, skin hot and dry, urine scanty, and there is continued fever. There is diminution of respiratory murmur in the affected part, and puerile breathing in the rest of the lungs. Dulness over the whole chest. In the third stage the expectoration is yellow and offensive, and contains yellow, tallow-like masses of degenerated lung-tissue. The strength fails, diarrhœa sets in, with profuse sweats, often hydrothorax and ascites, soon ending in death. The duration of the malady he states at from sixteen to twenty-two months, and only four cases out of 250 recovered.

On section the pleura was found thickened and spotted red, the cavity containing serum with shreds of albumen. The lung-tissue was broken down in spots into a grayish white pulp, and in other places was hard, tough, and of a pearl-gray color. The bronchial, tracheal, and laryngeal mucous membranes were reddened, and here and there slightly ulcerated (Hirt).

This disease, "phthisie cotonneuse," as it has been called, is not a common one. Most operatives undergo an acclimatization, and after a few days of discomfort are no longer troubled by the flying particles of dust and fibres. The dust, however, may irritate the exposed parts of the skin, and erythema and furuncles, as well as ciliary blepharitis are common. In the English mills the carders of India cotton are said to be troubled with urticaria, or an analogous affection on their hands and arms (Layet).

The atmosphere of the spinning-rooms has to be kept at quite a high temperature—about 84° Fahr. In some mills, where the finest thread is made, according to Proust the temperature is even kept at 104° Fahr. (40° C.). This exposes the operatives to the danger of taking cold, and they are almost all anæmic and troubled with their digestion.

The beating and hackling of flax and hemp disengages a great deal of dust, consisting largely of sandy particles. Flax-hackling, in particular, is one of the most unhealthy of trades; phthisis is very common among those who work at it, and there are few who do not suffer from cough and pains in the chest, even when they retain their strength. Out of 107 operatives examined by Dr. Greenhow, 79 had bronchial trouble and 19 hæmoptysis (Parkes).

Toulmouche (quoted by Proust) has described an inflammation of the mouth, and especially of the tongue, produced in hemp-spinners by their practice of continually wetting the thread with saliva, using the finger as a means, and thus conveying acid and irritating matters from the hemp to the tongue.

The extended use of machinery in performing the above-described operations has relieved the workmen of much of the danger to which they were exposed, and it is doubtful if cases of "phthisie cotonneuse" occur at all in this country.

Persons who are engaged in the manufacture of *tobacco* inhale dust which contains nicotine and some ammonia. It is not necessary here to describe the various processes of curing, sorting, stripping, cutting, and drying the leaf, or to go into the particulars of the manufacture of cigars and snuff. There is in all the rooms of a tobacco factory a strong odor of tobacco, caused chiefly by dust, and in the rooms where snuff is packed the atmosphere is fairly thick with it. The workmen are, therefore, all subjected in different degrees to the action of the tobacco-dust as an external irritant, and also to the absorption of nicotine by the system.

There is hardly any occupation about which such strongly dissentient opinions have been held by different investigators. While Ramazzini, in accordance with his usual pessimistic tendencies, declares that all the workmen are in general thin, pallid, yellow, and asthmatic, and suffer violent pains in the head, vertigo, nausea, and continual sneezing, and Heurtaux, Kostial, and others have agreed with him more or less, Parent-Duchâtelet, d'Arcet, Ygonin, Berutti, and Chevallier claim that workmen in tobacco factories are as healthy and long-lived as any other artisans, or even more so. The truth, as is apt to be the case in disputed questions, probably lies between these two extremes.

When persons first begin to work at tobacco they almost invariably suffer from headache, and often from nausea and vomiting. They pass sleepless nights and are frequently troubled with diarrhœa. These symptoms are more common in females than in males, and indicate a slight degree of poisoning by nicotine. In a week or two the symptoms wear away, and in the majority of cases no further trouble is experienced.

According to Heurtaux, physician to the manufactory at Paris, the

amount of fibrin in the blood is diminished, and tobacco-hands are peculiarly liable to passive congestions. Boudet, however, could find no change in the blood.

The effect of tobacco as an irritant is greatest in the manufacture of snuff. The first exposure of snuff-makers brings on a nasal and bronchial catarrh, with brown sputa, and frequently a conjunctivitis. In a few weeks the mucous membranes seem to lose their susceptibility to this irritant, and the workmen enjoy very good health. Their perfect immunity in a most trying atmosphere is surprising. I have seen a man who was packing yellow snuff in bags, in a room where the air looked like a London fog, and where I could not remain for a few seconds even without the most violent irritation of the nasal and conjunctival mucous membranes, and yet he told me he had worked in such an atmosphere for thirty years, had never had a sick day, and all his bodily functions were regularly performed, and to judge by the sparkle of his eye and the vigor of his movements he probably spoke the truth. It is pretty generally agreed of late years that men do not suffer in health by exposure to tobacco.

In most factories the workmen claim a certain amount of exemption from inflammatory and epidemic diseases. In New York I have been told that none of them died of cholera in 1854 and 1866, although the disease ravaged the locality in which they were. Mêlier believed in this protective influence to a certain extent, but Kostial states that the cholera found numerous victims among the female workers at Iglau. Ruef supposes that the workmen are almost exempt from neuralgias, rheumatism, and gout, while subject, on the other hand, to asthma, chronic bronchitis, and even phthisis.

That the occupation bears hardly upon the female sex is the universal observation. According to Kostial, out of 100 female cigar-makers, from 12 to 16 years of age, 72 fall sick within six months after beginning work. They suffer from headaches, præcordial anguish, palpitation, anæmia, lassitude, insomnia, feverishness, and anorexia. These are symptoms mainly of chloro-anæmia, and Layet does not hesitate to attribute them to the effect of premature labor and the bad sanitary condition of their homes.

Kostial states that abortions are frequent among the women employed in tobacco factories, on account of the death of the fœtus, and Ruef has discovered nicotine in the amniotic fluid. Heurtaux, Boudet, and Schneider have found this alkaloid in the urine, and Kostial affirms that the milk of nursing women has a strong odor of tobacco, although the presence of nicotine cannot be chemically demonstrated.

It has appeared to me, from observations made in cigar factories and in dispensary practice, that sexual development is decidedly retarded in young girls who enter the factories before the sexual evolution has begun, and in an investigation made by Dr. N. B. Emerson and myself on the condition of the cigar-makers who worked at their trade at home in crowded tenements, we were very much surprised at the smallness of the families. In the 124 families of which one of us took notes, there were only

136 children, or an average of 1.09 to each married couple, and in the 201 families visited by the other there were only 329 children, making an average of 1.63 to each married couple. When we consider the swarms of children that usually grow up in tenement-houses, in the families of the laboring and artisan classes, the paucity of offspring in a particular class becomes significant. The following are the figures we obtained:

No. of houses visited.	No. of families.	No. of persons.	Average to each family.	No. children.	Average to family.
18	124	414	3.33	136	1.09
23	201	805	4.	329	1.63

One family was found in which there were seven children. This being so remarkable an exception to the general rule, the family history was inquired into, and it was ascertained that the parents had only worked at cigar-making four years, having previously been farmers, and having had the greater portion of their numerous progeny while engaged in the latter occupation

The cause of this lack of fecundity among cigar-makers was not investigated. The observations of Heurtaux and Kostial on the presence of nicotine in the fluids of the body suggest that it may be due to frequent miscarriages.

There are but two autopsies of tobacco-workers on record which could be considered cases of tabacosis, and both of them are described by Zenker. He found the lungs very much atrophied and filled with numerous peculiar yellowish brown spots, due to a granular infiltration of the alveolar tissue. The infiltration was greatest where the atrophy was most extreme. On the other hand, Proust states that, having made several autopsies of these workmen, he has never seen appearances like those described by Zenker. Hirt, to test the question, exposed dogs and rabbits, for months at a time, to an atmosphere filled with tobacco particles. The animals remained healthy, had no catarrh or loss of appetite, and when killed the lungs were in spots strongly stained of a brownish color and atrophied, but there was no infiltration with tobacco. The atrophy did not coincide with the discoloration, as in the cases reported by Zenker.

It would seem, then, that no special preventive measures are necessary in tobacco factories, excepting perhaps to forbid the employment of children under puberty, and possibly of all females.

The occupations in which workmen inhale *animal* dust so as to appreciably affect their health are few. In *brush-making* the bristles have to be cleaned, and bleached with sulphur. The process of cleaning causes some dust, but not of an injurious character. When the bristles have

been fixed in their place, however, the workman trims them off with scissors to make an even surface. This operation fills the air with fragments of bristles, which cover the artisan's clothing, hair, face, and beard, and are inhaled with every breath. These fragments are tough and elastic, and cause great irritation of the bronchi. Whether they actually penetrate the lung-tissue is undetermined. They have never been found in the parenchyma after death. But their presence brings on bronchial catarrh, ulcerations of the mucous membrane, and phthisis. As will be seen by the table annexed, Hirt gives the very high percentage of 49.1 deaths by phthisis among brush-makers.

The chief danger of this trade would certainly be much diminished by the wearing of masks of fine wire-gauze.

Button-makers, and in general workmen who inhale bone-dust or horn-dust, are healthy men, but it is different with those who work in mother-of-pearl. The dust of this substance is very light and very irritating, producing in those who are exposed to it obstinate cough, chronic bronchial catarrh, and sometimes emphysema. Phthisis is not common. The workmen all suffer more or less from blepharitis and conjunctivitis, and from fissures of the skin of the hands, which are very painful and constantly reappear. Hirt refers to Englisch and Gussenbauer as describing a peculiar affection of the bones in button-makers exposed to mother-of-pearl dust. It is essentially an osteomyelitis, ascribed by them to infarction of the vessels of the marrow with dust which has entered the circulation. The lime-salts of the dust are dissolved, but the organic portion, the "conchiolin" (Frémy), is insoluble, and to it the disease is due. Hirt adds that he has never seen a case himself, although he made inquiries about it in many button factories.

The makers of *feather ornaments*, who are mostly women, inhale more or less dust containing particles of feathers. According to Hirt, the work can be carried on by any one person for only three years at the farthest, without great impairment of the health. The lungs and eyes both suffer. There is hardly a woman, who, after long employment at this work, does not have chronic inflammation of the eyes. At the post-mortem examination of a man, who, in order to sort the feathers better, had kept the doors and windows of his room closed, the main bronchi were found thickly plastered with feathers and almost obstructed.

Here also wire respirators would probably be of use.

Wool, as it is received at the factories, is very dirty and oily, and has to be cleaned. It is thoroughly washed, and the fatty matters are removed by alkaline solutions or carbon bisulphide. The smell given off during these operations is offensive, but the workmen are healthy, and, like others who inhale oily vapors, they seem to possess a certain immunity against epidemics. The combing of the wool causes some dust, but the operatives are never troubled by it. The particles of woolly fibre are pliable and exert no irritant effect on the mucous membrane of the lungs, as hairs do by reason of their stiffness. The female spinners in woollen-mills are said by Hirt to be pale and thin, weary-looking, lazy, and drowsy.

Their menses are seldom regular and often profuse. On the other hand, Thompson thinks them very healthy and well-nourished. My own observations coincide with the latter decidedly.

The *carders* of *floss silk* suffer more from their occupation than any other silk-operatives. They work in a sitting position, in close, badly-ventilated rooms, and inhale a great deal of dust mingled with offensive vapors of animal origin. According to Tardieu they suffer from œdema of the limbs, dull pains in the arms, shoulders, and thorax, obstinate ophthalmias, fatiguing cough, asthma, hæmoptysis, and phthisis. They are subject to cutaneous eruptions, and may easily be recognized by their pale faces, puffy red eyes, and constant slight cough. The stoutest and most vigorous among them are forced to abandon the work at 48 or 50 years of age, and frequently earlier. Hirt considers that the French writers have exaggerated the evil effects of this occupation, and that silk-operatives are not much troubled by dust.

In order to remove the gelatinous material that binds the threads of the cocoons together, they are soaked in hot water and there manipulated by workmen, who are somewhat liable in consequence to a peculiar malady, first described by Potton, and called the "mal des bassines." The skin in all becomes pale and macerated, with hyperæsthesia of the extremities of the fingers; but Potton's disease is now rare. It can be recognized when the redness, pain, and swelling of the hands, experienced by all new-comers, does not relax after fourteen or fifteen days. Vesicles then appear, which soon become pustular, and very tender and painful. In five or six days pus is discharged, and they dry up. If work is persisted in after this disease begins, œdema of the cellular tissue, inflammation of the lymphatic glands, and considerable prostration may follow. Patients always recover. Potton attributed the malady to the irritation of putrefying animal matter, Layet to the gelatinous substance which glues the fibres together. Hirt found that the cleaner the water and the lower its temperature, the less frequent was the disease, which is probably a form of eczema.

The weight of silk is sometimes increased by washing it in a solution of acetate of lead. Eulenberg found 17.71 grammes of lead in 100 grammes of silk. Chevallier found 20 parts of the acetate of lead in every 100 parts of silk, in many specimens bought at different factories. In using silk thus prepared, spinners are liable to lead-poisoning, from their habit of drawing the threads through the mouth. Many such cases have occurred in Lyons (Oesterlen).

Dron (quoted by Layet) has called attention to the effects of the use of methylic alcohol in the preparation of silk tissues. The workmen suffer from acute conjunctivitis, intense coryza, headache, sense of weight and constriction at the top of the head. In some cases there is anorexia, nausea, or vomiting, and in others veritable tetanic contractions of the fingers. M. Poincaré has recently made experiments with this substance, and found that in animals the livers showed enlargement and fatty degeneration. The latter was observed also in the muscular fibres of the heart,

in the epithelial cells of the uriniferous tubules, and in the lung-cells. There was also more or less congestion of the nerve-centres.

Carpet-beaters, *hair-pickers*, and *street-sweepers* inhale mixed dust. *Carpet-beating* dislodges an immense amount of dust, partly mineral and partly animal (wool), and when it is done by hand, or if special means be not adopted for ventilation, the workmen suffer from nasal and bronchial catarrh to some extent. Irritation from this source may be entirely prevented by the use of a large hood over the carpet-cleaning machine, and of a fan to draw away the dust.

Hair-picking also raises clouds of dust, and keeps the workmen constantly coughing. The hairs, moreover, are stiff, and when inhaled tend to create permanent irritation of the trachea and bronchi, as in brush-makers.

The dressing of hair for pillows, mattresses, etc., sometimes gives rise to serious disease. The hair which comes from Siberia and other parts of Russia is particularly dangerous, those who handle it occasionally contracting malignant pustule. The cause of this poisonous quality is not surely known, but it is probable that some of the Russian hair is pulled from putrefying carcasses, or perhaps from the bodies of animals that have died of contagious disease. According to Layet, even glanders has been communicated in this way.

The dust caused by hair-picking may be removed by a mechanical fan, and it would certainly be prudent, in view of the number of cases of malignant pustule caused by handling Russian hair, to always fumigate it with sulphur before it is given out to the workmen.

The mingled mineral, animal, and vegetable dust raised by *street-sweeping* may be diminished in amount by sprinkling the street beforehand. The inhalation of the dust does not seem to affect the sweepers injuriously.

b. *Occupations which expose persons to the inhalation of* POISONOUS *dust.*

The trades included under this heading mostly have to do with preparations of *arsenic*, *mercury*, and *lead*. These three metals, in the form of their salts, are very extensively used in the arts, and are introduced into the systems of the workmen in three ways, viz., through the alimentary canal, when by the carelessness of the employer the men are allowed to eat their meals in the workroom ; through the skin by absorption ; and through the respiratory mucous membrane by inhalation of the dust flying in the air. Which of these methods of intoxication is the most common in any particular occupation it is impossible to say, as sometimes they are all operative, and in most cases the last two are, and there is no way of estimating the probable influence of each factor in bringing about the result.

The arsenical preparations produce a local effect on the skin, where it is covered by the poison. With this exception these poisons do not irritate, and their poisonous influence is first manifested by the signs of

general intoxication. When this occurs, cessation of work is imperative, There is no such thing as acclimatization to the air of such a workroom, and continued exposure involves increased derangement of nutrition, and finally death.

In the manufacture of *artificial flowers* various coloring matters are used, and some of them contain arsenic. This is especially the case with the greens, which consist mainly of the arsenite of copper (Scheele's green), or a double salt of the arsenite and acetate of copper (Schweinfurt green). These substances are used in solutions into which the material to be colored is dipped, and when the latter is dried and further manipulated, more or less of the arsenical salt is shaken off in fine powder. The air of the workrooms is, therefore, constantly contaminated with the dust, which enters the body by two channels: through the lungs and through the skin.

Among the workmen who are exposed to this poison, acute poisoning is very rare ; but they often lose their appetite, complain of palpitation, violent pains in the stomach, intestinal derangement, constant headache, and a feeling of depression. A capital and characteristic sign of the effect of the poison is enfeeblement of the muscular force, especially of the limbs. This feebleness may develop into paralysis, and persist long after work is abandoned. Vesicular or pustular eruptions appear on the face and hands, and generally also on the scrotum. Their development in the latter situation is usually attributed to contact of the hands. The eruption sometimes leads to ulcerations, which have hard borders and yellowish gray bottoms, so as to closely simulate syphilitic sores. If the fingers are abraded or wounded, hemorrhagic pustules appear, and occasionally gangrene follows. When picric acid is used, it aggravates the trouble.

The hands of the makers of artificial flowers are stained yellow by picric acid, which also stains the finger-nails of the same color. The accumulation of arsenical salts beneath the nails makes their ends green, and the appearance of the hands is thus made highly characteristic.

Some kinds of *wall-paper* are colored with arsenical greens, and the workmen engaged in their manufacture suffer in consequence. The so-called velvet-paper is made by sprinkling the powdered color on a surface covered with gum, and more or less of this powder is inhaled by the artisan.

The symptoms of general intoxication, however, are rare among those who work with arsenical colors, the evil effects being almost confined to cutaneous eruptions and ulcerations.

The workmen should wash off every particle of the poisonous substance from their bodies after quitting work, and especially when they are to take their meals. Layet recommends for this purpose the use of a solution of hydrochloric acid, 10 parts to 100 of water, which completely dissolves the arsenite of copper. The meals should never be eaten in the workroom. Any abrasions or wounds should be carefully protected with

collodion or plaster, as they are particularly liable to become ulcerated. Layet recommends also that the hands be covered with powdered soapstone during labor; but this, it would seem, might interfere with the necessary delicacy of touch.

The best preventive of disease in such occupations is to give up the use of poisonous preparations altogether; but it is said that the arsenical colors excel so much in brilliancy any that can be substituted for them, that their use must be continued. Layet suggests that a combination of zinc chromate and ferric cyanide produces a most brilliant and beautiful green.

Hatters, in order to remove the hair from skins, brush over the hairy surface a solution of acid nitrate of mercury, often adding to it 3 or 4 parts of arsenious acid and 1 to 3 of bichloride of mercury. The moist hide is then put in a drying-chamber, and after drying is beaten or brushed against the grain. This process gives rise to much dust, and its inhalation produces mercurial poisoning. The preparation of the acid nitrate in the shop sends off nitrous fumes, which produce great irritation of the nasal and laryngeal mucous membranes, sometimes followed by emphysema and asthma. Symptoms of acute mercurial poisoning are not common, but the workmen are pale, emaciated, and suffer from mercurial tremor and premature old age. The felt, after it is made, is "fulled" by dipping it in a hot dilute solution of acetic or sulphuric acid, and the workmen who do this part of the work inhale acid fumes, without, however, any bad effect.

In order to prevent mercurial poisoning, Hillairet and Bergeron have proposed, and Hirt strongly commends the suggestion that, instead of using a mercurial solution on the skins, they should be brushed over with molasses, or a solution of dextrin or sugar, and then washed with dilute nitric acid. This process involves more work than the other, and as the hairs dry more slowly there will be a greater consumption of fuel; but the same final result is attained, and the danger of the mercurial method is entirely done away with.

Dron has observed at Lyons the effects of exposure to the vapors of methylic alcohol on workmen who dip the felt hats, when nearly finished, in a solution of gum in that fluid, to render the felt impermeable. The symptoms have already been mentioned under "*Silk-operatives.*" Bergeron, on the other hand, has made investigation of the same subject, with regard to hatters, manufacturers of aniline colors, gauze-makers, cabinet- and piano-makers, and even the men who manufacture the alcohol itself, and found that no bad results followed its use, excepting in rare cases, and he attributes the symptoms described by Dron to the bad quality of the alcohol used, the deleterious ingredient, however, not being mentioned.

The manufacture of the different preparations of *lead,* which are largely used for paints, produces lead-poisoning in a certain percentage of workmen. The symptoms of this form of intoxication are too well known to need description here. The metal is introduced into the body either by

inhalation in the form of powder, or through the digestive organs, or by absorption through the skin, which is now pretty well settled. Proust relates the case of a painter who had a habit of keeping in his mouth, on the right side, small freshly painted bits of wood. The tongue and internal surface of the cheek on this side suffered a considerable loss of sensibility, and the sense of taste was altered, while the left side remained unaffected. This shows very prominently the local effect of the poison. Lead, like mercury, affects women more readily and more seriously than men. They suffer from metrorrhagia and have frequent abortions. Constantin Paul, quoted by Tardieu, observed that of 141 pregnant women whose husbands worked in lead, 82 aborted, 4 had premature births, and 5 of the remaining children were still-born. Of the 50 living children, 20 died before they were a year old, and 15 more before they completed their third year. Out of 43 pregnancies in women who suffered from lead-poisoning, there were 32 premature births, 3 still-born, and 2 very delicate living children. These figures are very significant.

Of the different lead-salts, viz., white-lead (lead carbonate), acetate of lead, litharge, chromate of lead, etc., the first is generally held to involve the most peril to the workman. The following figures are taken from Layet: in the Paris hospitals, during the years 1844–'46, there were treated 1,450 cases of lead colic; of this number, the makers of white- and red-lead were 796; painters of buildings and carriages, 290; printers, type-founders, etc., 120; makers of white enamelled cards, 35; potters and enamellers, 33, and the remaining number divided among many other trades.

The most dangerous parts of the manufacture are the crushing or grinding and the sifting of the lead-salts, which fill the air of the work-room with a fine powder.

The workmen in *lead-mines* suffer greatly. According to Hirt, out of 2,000 miners in Saxony, 1,743 were poisoned, and almost all have the blue line on their gums (Burton's line).

Enamellers also suffer from lead-poisoning, as lead is always the base of enamels, which are essentially silicates of lead, colored with iron or copper.

Painters use white-lead almost constantly, and furnish a large proportion of the cases of lead-poisoning. They are also occasionally troubled with headache, dyspepsia and muscular weakness, attributable to the inhalation of the spirits of turpentine with which their colors are mixed. Boutigny has even seen porcelain-painters obliged to give up their situations on account of the violent headache and vertigo caused by this substance.

Type-metal consists of four parts lead and one part antimony. Type-founders suffer from lead-poisoning to some extent.

Many different plans have been suggested for the prevention of lead-poisoning, but most of them have been tried, with indifferent success. Masks and respirators are objected to by the workmen because they make the face hot and uncomfortable, and because they interfere somewhat with the respiration. It has been proposed that the men should all take doses

of potassium iodide regularly, but this interferes with digestion and is uncertain in its effect. Sulphuric acid lemonade has been tried in many places, but has been given up as of no value. Chevallier recommended a drink composed of nineteen parts of water to one of hydrosulphuric acid, and a little sodium bicarbonate—a highly palatable mixture (!), but useless. The best preventive means appear to be these: all sifting and crushing apparatus should be as tight as possible, so as to prevent the escape of dust; the rooms should be well ventilated; meals should never be eaten in the workroom; the hands and face should be washed before eating and after work is over, and it is also well to brush the teeth and rinse the mouth with a weak solution of sulphuric acid. According to Hirt, milk is a perfect prophylactic. A litre or a litre and a half a day is sufficient for the purpose. He states that no workman who uses it habitually ever suffers from lead-poisoning. It is difficult to see why this should be so. The lead certainly enters the body; and it would seem as if the milk, to be efficient, must assist in its elimination. Fatty food has long been recommended for the same purpose, and it is no worse than many other gross chemical explanations of physiological phenomena to suppose that the fatty constituents of the milk form a soap with the lead, which is thus rendered soluble, and rapidly excreted.

Hirt strongly recommends the use of zinc-white instead of white-lead in the arts, and if such use became general, it would certainly do away with the majority of cases of lead-poisoning.

Workmen who inhale the dust of *copper* or its salts are more liable to lung disease than those who work in iron, although Deroche has claimed that copper has an anti-phthisical effect. At the recent session of the International Congress of Hygiene, in Paris (1878), M. Bugy maintained that workers in copper were remarkably exempt from epidemic diseases, in which opinion he was supported by Mormisse.

Coppersmiths in general do not seem to suffer at all in health from their work. The men who finish pieces of casting, however, filing off the asperities, inhale a great deal of dust, and suffer much from bronchitis. *Bronze powder*, too, is made by filing copper or brass, and the operation is very injurious to health. Bronchial catarrh and phthisis are common among the workmen. In a factory at Nuremberg, Hirt found almost all the workmen pale and emaciated, and all without exception complained of the unhealthiness of their occupation. The firm stated that the men all suffered from cough, many had phthisis, and that they seldom lived beyond fifty.

The *acetate of copper* is made by exposing copper plates to the action of acetic acid, and the crystals which form are scraped off and some dust evolved. The men who work at this at first have acute bronchial catarrh, sore throat, conjunctivitis, and suffer from pains in the chest and tickling in the throat. These symptoms do not last long, and after recovery the workmen remain sound.

Watchmakers and clockmakers are somewhat exposed to copper-dust, and M. Perron states that the workmen at Besançon suffer from pains in

the epigastric region and head, and from frequent indigestion and diarrhœa. Some are troubled with tickling and a sense of constriction in the throat.

There is hardly a question in the whole range of medicine which has been more and longer discussed, without being decided, than that of the existence of such an affection as copper colic. There seems to have been little doubt upon the point until within the past thirty years, but the manner in which the dispute has been kept up shows that its settlement is far from easy.

The copper colic is said, by those who believe in it, to differ from lead colic in being attended with extreme prostration, and with diarrhœa instead of constipation. It is not of long duration, and the prognosis is always favorable. It is said that the use of fresh milk in copious draughts prevents its development. By those who do not consider copper a poison, these symptoms are attributed to a mixture of other metals. It is rare to work with chemically pure copper, they say, and the bad effects are produced by the lead, zinc or arsenic with which the metal is alloyed. Others consider metallic copper harmless, but its salts as poisonous, and explain the symptoms above mentioned as caused by the acetate or carbonate of copper.

There is no doubt that the metal is absorbed in the body. The coppersmiths of Durfort, according to Millon, have green hair, and their urine stains the wall and ground of a green color. The bones are said to have been found green (though Hirt ridicules the statement), and the hair and scalp have been analyzed and found to contain acetate of copper. Millon and Perron insist that in certain copper-workers there is a deposit of copper molecules on the gums and teeth, forming a reddish purple line, first noticed by Corrigan. Bailly (quoted by Proust) describes the characteristic line as greenish blue, and states that the reddish brown precipitate of oxide of copper is readily obtained with potassium ferrocyanide. If then copper enters the system in sufficient quantity to stain the excretions and be deposited in appreciable amount in the tissues, cases of chronic poisoning by it should be pretty common, if it is to be classed in the same category with lead and mercury. But, on the contrary, cases of copper colic or chronic poisoning in any form are acknowledged by all to be extremely rare; and indeed, if it were common, its existence would not be a matter of doubt. I have, moreover, been unable to find that copper colic has ever been observed in workmen who used copper alone. Most of the cases mentioned are of workers in brass, and those who use a solder partly composed of lead. According to Chevallier, those who have had colic more than once are liable to suffer in time from paralysis of the extensors of the hands. This is additional reason for believing the so-called copper colic to be really lead colic.

When we consider, therefore, the rarity of copper colic, its similarity to lead colic, that copper-workers also work with lead, that a majority of workmen who are even saturated with copper do not suffer in health thereby, and that they consider the drinking of fresh milk a preventive to

colic (as do also workers in lead), it seems probable that the only bad effects clearly traceable to the inhalation of the dust of copper are those due to irritation simply, and not to metallic poisoning.

The methods of preventing diseases due to the inhalation of dust are therefore chiefly these:

1. Prevention of the formation or escape of dust (wet grinding, close vessels, etc.). Not often practicable.
2. Prevention of the inhalation of dust (respirators, masks, etc.). Not comfortable for workmen.
3. Removal of dust as fast as it is produced (mechanical fans, air-shafts, etc.). Best plan of all.

As regards individual workmen:

1. They should change their outer clothing after work.
2. They should keep face and hands clean.
3. They should never eat in the workroom.
4. No women or children should be employed in dangerous occupations.

Special precautions for particular occupations are mentioned under the respective headings.

2. *Occupations involving the introduction of deleterious matters into the body by* ABSORPTION.

The matters absorbed may act as mere local irritants, or affect the whole system. It seems at first inappropriate to describe an external irritant as acting by absorption; but the superficial layers of the epidermis are certainly not capable of irritation, and in order to produce the symptoms of vascular and nervous excitation, something must have penetrated to a sufficient depth to meet living tissues, or else we must accept the idea of action at a distance.

a. *Occupations which expose persons to the absorption of* IRRITATING *substances.*

Domestics, washerwomen, and others who have their hands constantly in irritating fluids, have the epidermis softened and blanched. The soap, often strongly alkaline, removes the fatty ingredients of the epidermis, and makes it brittle, so that it tears and cracks. In other cases obstinate eczema is caused, known commonly as "salt-rheum." The strain of the wrists in wringing the clothes sometimes brings on painful crepitation of the wrist-tendons, and the slight wounds received from pins, etc., being constantly soaked in soap-suds, may give rise to panaris. In some persons, either the action of the alkali (Romberg) or long immersion in cold water (Hirt) produces stiffness and numbness of the hands and forearms, with tearing pains as far as the elbow, much worse at night. Sensation is impaired, but motility unaltered. Hirt considers the symptoms to be due to arterial cramp, and adduces the paleness of the surface and diminution of temperature (sometimes amounting to 2° C.) in support of his

view. Washerwomen constantly run a certain risk in washing the clothing of sick persons. According to Griesinger, typhoid fever is extremely common among hospital laundresses, and in cholera epidemics these women have been stricken down in great numbers (Layet).

Some of these evils may be prevented by care in the selection of soap, by the use of mechanical wringers, and by the disinfection of infected clothing.

Grocers suffer occasionally from eczema, called "grocer's itch." It is caused by the handling of irritating substances, such as alkalies, coarse sugars, soaps, flour, etc. The hands become chapped and fissured, and sometimes very painful. The cracks are usually at the flexures of the joints.

Special attention to cleanliness would seem to be the only preventive.

b. *Occupations which expose persons to the absorption of* POISONOUS *substances.*

The occupations here treated of—*pæderasty* and *prostitution*—expose their followers especially to the syphilitic virus. As the subject of syphilis is fully discussed in another chapter, it only remains to consider some of the other physical phenomena which are fairly attributable to these practices.

Tardieu has published an elaborate paper on the subject of pæderasty, from which the following statements are taken :

During attempts made by the police to suppress pæderasty in Paris he had the opportunity of examining on one occasion ninety-seven, and on another fifty-two persons taken in the act. He also visited at different times sixty others, besides examining many dead bodies of persons on whom the crime had been practised.

With regard to ages and occupations he gives the following table:

Age.	Number.	Occupation.	Number.
12–15 years.	13	Servants.	44
15–25 "	65	Merchants' clerks.	29
25–35 "	26	Tailors.	12
35–45 "	28	Military men.	12
45–55 "	19	108 others belonging to 59 different occupations.	
55–65 "	5		
65–75 "	4		
Not given.	46		

Casper states that persons may be pæderasts of long standing and show no signs of it, but Tardieu says that out of 205 avowed pæderasts he has only found fourteen in whom it was impossible to find an evident trace of their habits. Out of this total, those whose habits were exclusively passive numbered 99 ; those with habits exclusively active, 18 ; both active and passive, 71 ; not given, 17.

With this immense experience, he gives these as the effects of this peculiar occupation.

Passive pæderasty produces an excessive development of the buttocks, an infundibuliform appearance of the anus, relaxed sphincter, effacement of the folds, carunculæ of the anal orifice, incontinence of the fæces, ulcerations, fissures, etc.

The infundibuliform anus has generally been considered a pathognomonic sign. It is, however, not always present, but was found in 100 cases out of 170. It may be absent in persons with very fat or very thin buttocks. Tardieu believes relaxation of the sphincter to be fully as true and characteristic a sign. He found it existing in 110 out of 170 cases.

The natural folds and puckers are effaced, and the anus is smooth and polished, the *podex lævis* of the Romans. The use of emollients to facilitate approaches causes relaxation of the tissues to such an extent as to produce a sort of prolapse of the mucous membrane, so that in several cases it resembled the labia minora of the female.

In active pæderasts the penis was found very small or very large. The large penis is rare, but in all cases the dimensions of the organ are excessive in one sense or the other, *i. e.*, of the organ when not in a state of erection. Its form is very characteristic. When small and thin, it diminishes towards the glans, which is quite small, so that the penis resembles that of a dog. This is the most common shape, and suggests the idea that the tendency of some individuals toward this unnatural vice may be due to an incapacity for ordinary sexual intercourse.

When the penis is voluminous, the whole organ does not taper in size. The glans only is elongated, and the penis is twisted upon itself, so that the meatus is directed obliquely toward the right or left. This distortion is sometimes very marked, and appears more pronounced as the dimensions of the organ are more considerable.

Prostitutes, besides the risk of syphilis, live under conditions which produce in time marked physical effects. As a result of their extremely indolent life, their habitual indulgence in alcoholic stimulants, and their practice of eating the best food they can obtain, they have a decided tendency to corpulence, which shows itself markedly in those who are over twenty-five years of age. That this tendency is not connected with frequent sexual gratification, but is due to their easy life and plentiful nourishment, is shown by the fact that it is much less common in the lowest class of prostitutes, who live on poor food, are often stinted in that, and are harassed with anxiety about their future as much as women of their class in any other occupation.

Prostitutes of several years' standing acquire a peculiar timbre of voice, which is very characteristic, and is probably due to a slight chronic laryngitis. The use of strong alcoholic liquors, and the frequent straining of the voice in brawls, and even in conversation, are probably the main factors in its development.

II.

Occupations involving exposure to conditions that interfere with nutrition.

These conditions may be classified under three headings, viz.: an abnormally high temperature or sudden variations of temperature, by which the functions of the vaso-motor nerves are disordered; the straining or over-use of organs, by which certain parts of the body are nourished at the expense of others, or are even subjected to mechanical violence; and a constrained attitude, by which necessary rest is withheld from certain organs, or they are so compressed, or their proper motions so interfered with, that disordered function in them finally becomes disease.

1. Elevated or Variable Temperature.

a. *Occupations in which persons are exposed to the vicissitudes of the weather.*

Those who are engaged in out-of-door occupations, as a rule, breathe a pure air and have plenty of muscular exercise. They are usually robust and brawny, and the average duration of their lives is long. But, being exposed to alternations of cold and heat, to wind, rain, and snow, they are peculiarly liable to acute pulmonary affections and rheumatism.

Boatmen and *fishermen* are very liable to chronic bronchial catarrh. The latter are said to suffer frequently from panaris of the right index finger, due to the rubbing of the line.

Farmers and *agricultural laborers* in general are often attacked with catarrh and pneumonia, and the elderly and aged ones almost invariably suffer a great deal from chronic rheumatism. The life of an independent farmer is so free from anxiety and so healthful in its conditions, that, if it were not for the poorness of the food set forth on most farmers' tables, their lives would be much longer and more comfortable than they are. But in most farm-houses the diet is very much restricted, the meat consisting almost exclusively of salt-pork, and the cooking is execrable, so that dyspepsia is common. As the men lead an altogether out-of-door life, the effects of this indigestible stuff appear less in them than in the women, who work in-doors, and, being more delicate in their organization, break down earlier. More pitiful wrecks of women, by reason of hard work and poor food, than some of the farmers' wives of New England, it would be hard to find.

Drivers of carts, hacks, omnibuses, etc., are particularly exposed to cold blasts and to the full sweep of rain, snow, and sleet. They constitute almost the only class of laborers who are exposed to the full effects of inclement weather, and they are very commonly attacked with pneumonia and rheumatism. They are also very liable to facial paralysis, apparently due to inflammation of the sheath of the facial nerve near its place of

emergence beneath the ear. According to Hamilton, the car-drivers on city railroads are troubled with varicose veins of the legs and congestion of the spinal cord or its meninges, from the constant jarring to which they are subjected. The red nose, which is so common in this class, and which has been usually attributed to a vaso-motor paralysis due to intemperate habits, is believed by Hirt to be often really caused by habitual exposure to the elements.

Laborers furnish a large contingent of deaths by phthisis and Bright's disease yearly, and arc somewhat more liable than others to sunstroke.

Bricklayers and *masons* are liable to accident from falling scaffolds, loose building material, etc.

b. *Occupations in which persons are exposed to extreme artificial heat.*

Where the atmosphere of the workroom is necessarily kept at a high temperature, the ventilation is usually poor, for a rapid change of the air would compel an increased consumption of fuel. Whether, then, the high temperature or the bad air be the cause, it is certain that persons who work under these conditions are generally anæmic, and their power of resisting epidemic disease is much reduced. The copious perspiration has much to do undoubtedly with the exhaustion of their vitality, and the sudden and marked changes of temperature which they undergo when they leave work and pass into the external air, render them peculiarly liable to catarrhal difficulties, both pulmonary and gastro-intestinal. They are also subject to Bright's disease and rheumatism, and it has been long remarked that meningitis was common among them.

Brickmakers are generally robust and healthy men. Those who press the clay into the moulds by hand are said to be subject to painful crepitation of the tendons at the wrist, due to synovitis. They are exposed to smoke and heat from the kilns, and suffer somewhat from blepharitis and conjunctivitis.

Bakers and *cooks* are exposed to great heat in almost invariably badly ventilated kitchens. The former work at night, and very often in cellars, and their pale, puffy faces are very characteristic. They are both very subject to rheumatism, to varicose veins, and, according to Malgaigne, to hernia. The heat of the fire and the irritating substances in which they work produce eruptions of eczema and lichen on the hands and arms, and acne on the face.

Of the two trades, that of baker is the most unhealthy. When the plague visited Marseilles in 1720, all the bakers died, and the needs of the inhabitants had to be supplied from the neighboring towns. The same excessive mortality among this class has been remarked by Clot-Bey in the East, and has been noticed by various authors in epidemics of yellow fever, cholera, and typhus. This is an indication, certainly, of a profound sapping of the vital forces.

The hands of bakers are generally large and powerful, as Hirt thinks, because of the muscular exertion expended in kneading dough.

Charcoal-burners are exposed to a temperature of from 108° to 112° Fahr., but do not seem to be injured by it, as their work is done in the open air. They are also unaffected in any appreciable degree by the carbonic oxide and carbonic anhydride which they must inhale to some extent while at work. They are said, however, to be somewhat subject to hemeralopia.

Blacksmiths are strong and healthy men, partly because only the robust can endure the labor incident to this trade, and partly because the constant muscular exercise tends to increase the natural vigor of those who adopt it. But the extreme exertion, the exposure to the heat of the forge, the profuse perspiration and sudden changes of temperature, are so many sources of constant peril to the health, and it is the universal testimony of writers on hygiene that they become prematurely aged. Chronic bronchial catarrh is common among them, but phthisis is very rare, and pleurisy and pneumonia are not often observed. The daily and prolonged exposure to radiant heat and intense light from the forge and the white-hot metal produces affections of the eyes—chronic blepharitis, presbyopia, and mydriasis with diminished contractility of the pupil (Layet). They also suffer frequently from traumatic lesions, mostly burns and slight wounds of the cornea from flying bits of metal, which are often incandescent.

They are said to have frequent, intense headaches, and to be peculiarly subject to furuncles and anthrax.

The sudden changes of temperature naturally produce acute and chronic rheumatism. Maisonneuve (de Rochefort) has described lumbago as common among them, and attributes it to the straining of the lumbo-sacral and sciatic ligaments, with occasional implication of the spinal cord. Layet, on investigation of this subject, has satisfied himself that it is due, at least sometimes, to renal congestion and inflammation, as he found albuminous urine in a number of cases.

Engineers and *stokers* on railroads, in steamships, and with stationary engines, are exposed to a temperature above that of the external air. On steamers, where their quarters are contracted, they are a very unhealthy class of men, especially the stokers. They are pale, subject to catarrhs, rheumatism and pneumonia, and frequently die of phthisis.

Hirt takes from Bourel-Roncière and Fonssagrives a description of a peculiar affection which sometimes supervenes in men who clean out the boilers of steam-engines. They enter by a man-hole, and after a few minutes emerge with their faces red, lips blue, veins swollen, interrupted respiration, and heart-beats barely perceptible. They have photophobia for many days, and are apt to have stomatitis, and sometimes gastric catarrh, diarrhœa, etc. There is a peculiar whiteness of the mucous membrane of the lips, as if they had been touched with nitrate of silver, and a partial opacity of the cornea, as if a caustic had been used upon it. The cause of these symptoms is very obscure.

These workmen are also liable to serious accidents from bursting boilers, breaking shafts, etc.

Men who work at large *forges*, *iron-puddlers*, *glass-blowers*, etc., are exposed constantly to a most intense heat. Hirt states that *iron-puddlers* work from eight to ten hours in air of a temperature of 130° Fahr. Such workmen are constantly sweating profusely, and drink enormous quantities of water to make up for their loss. They are subject to all the diseases incident to such exposure and to sudden changes of temperature, viz., bronchitis, pneumonia, rheumatism, and diarrhœa. They also suffer from blepharitis and conjunctivitis, and have a tendency to retinal or choroidal inflammation, as an effect of the vivid light on their eyes. The heat gives rise to irritation of the exposed surface of the skin, and erythema, eczematous and lichenoid eruptions, furuncles, and axillary abscesses, are far from uncommon among them.

They are also said to be quite subject to cataract, which has been attributed by some to the bright light of the furnace, and by others to radiant heat. Proust suggests that it may result from the profuse sweats which render the fluids of the body denser and richer in salts, and so affect the nutrition of the lens; and instances the experiments of Kunde, who put frogs in a heated chamber, and when they had lost considerable water by evaporation, opacity of the lens was produced, but disappeared when the animals were plunged in water again. This cause is quite as active, however, among the attendants in Turkish baths, and no tendency to cataract has been observed among them. Hirt believes that all cases of cataract in this class of artisans are due to senile changes or traumatism.

Glass-blowers take a mass of molten glass from the furnace on the end of a tube, and blow into it while it is soft. As the lung capacity of one man is insufficient for the purpose, two, three, or four stand together, and the tube is passed immediately from one to another. The end of the tube is often rough, and the men suffer from cracks and abrasions of the lips, and syphilis has been often communicated in this manner. It has been proposed that each man should have his own mouth-piece, which can be instantly applied to the common tube. Where this has been tried in France, the workmen have abandoned it from dislike, and have voluntarily submitted themselves to medical inspection. In spite of the utmost care, however, syphilis is still occasionally transmitted in this way.

The violent effort of blowing tends to produce emphysema, and heart disease and Bright's disease are common.

Forgemen and puddlers, who handle immense masses of metal and heavy tools, have frequent occasion for extraordinary muscular effort, and hypertrophy of the heart is said to be common among them as a consequence.

Dyers, being exposed to wet and to an habitual temperature of about 100° Fahr., are liable to catarrhs and rheumatism. The fluids in which their hands are immersed produce cutaneous eruptions, generally eczematous, and ulcerations or fissures of the hands and fingers.

Laundresses suffer somewhat from exposure to a high temperature, and are apt to be anæmic. Vernois has noticed an habitual luxation of the left thumb backward, as a result of its constant use in holding cloths

firmly on the ironing-board. According to Tardieu, all the fingers of the left hand can be bent backward to a remarkable extent.

2. Over-use of certain Organs.

a. *Occupations involving over-use or abuse of the nervous system.*

It is generally believed, and probably with reason, that men of the present age spend too much time in exhausting labor, and too little in recuperation. However this may be, there are certain occupations in which the wear and tear of the nervous system is very great. The character of the occupation is such that the attention is almost necessarily fixed upon it during the whole of the waking hours, and the constant tension without relief causes a waste of nerve force which the hours devoted to sleep are not always long enough to repair. To the actual expenditure of nerve-force in intellectual labor is added the most exhausting of all functional disturbances, viz., "worry," a disturbance which probably implies a profound and wide-reaching molecular disorder in the brain, for it is more frequently followed by insanity than any other cause excepting positive lesions. This condition of molecular instability, or "worry," is due to the fact that the occupations referred to have to do with contingent events almost entirely, so that the normal placid current of nerve-force common to those who know every day what they have to do and do it, is utterly impossible.

The exhaustion brought about by this continual waste of nerve-tissue and unceasing molecular conflict, so to speak, is not only a source of danger, but of suffering. To obviate the ill-effects of an irregular and unnaturally wearing life, stimulants are too often resorted to, which supply for a time an artificial strength, until finally there comes a complete breaking up, and the poor man dies, or lingers the mere wreck of what he once was.

The persons who fall more immediately in this category are *brokers*, *merchants*, and *gamblers*. The latter risk their health still more by irregular hours and night-work. Brokers and merchants, in large numbers, hurry themselves into a dyspepsia by bolting their meals and gulping down hot drinks as if for a wager. No more saddening and ludicrous sight combined can be seen than a lunch-counter in the business part of New York from 12 till 2 P.M. One can pick out almost unerringly among the struggling crowd those who already begin to feel the results of their unwholesome way of living, and those who are on the brink of collapse.

The advice to be given to such men is already trite. It is simply moderation. Don't work so hard, nor eat so fast, nor worry so much. Such advice does no good, for it is never heeded. The scramble goes on, the weak ones are soon weeded out, and a few who are more robust and more cautious than the rest reach a ripe old age.

Physicians are exposed to many special causes of disease and death. Their duties toward their clients are of the most wearing kind. No per-

son outside the profession can appreciate the weight of responsibility a medical man often assumes when a patient's life is in the balance. This responsibility and the anxiety resulting from it would be heavy enough if it were only a matter of bread and butter to him, a matter of retaining or losing a patient, of professional success or failure. But the cares of all the relatives and friends are often thrown upon him, family secrets are communicated to him, women come for worldly advice—in short, he must often be not only physician, but confessor. Besides his constant mental anxiety, he lives under the most unhygienic conditions physically. His time is never his own. His sleep is interrupted ; he must work by night as well as by day ; he is expected never to plead fatigue, and the hour of his meals is the very hour selected by many persons to consult him. The life of a physician in large practice cannot be paralleled for irregularity in every respect.

Add to this that he is constantly exposed to contagious disease, and that frequently when he is fatigued and hungry, and that he often risks a rapid and awful death by the inoculation of poison from dead bodies in autopsies and dissections, and we have an array of morbific agencies acting upon his system with more or less persistency that is positively appalling.

And all of these destructive agencies do their work finally. This is shown by the stern statistics of the mortality lists in countries where they are carefully kept. In England the average age of physicians at death is given as 45. Old physicians are rare. In war the number of deaths among medical men is startling. During the Crimean war, while the general mortality among officers of all grades was 14 in 100, the surgeons who died of sickness and various accidents numbered 18.22 in 100. In the same war typhus fever took off 0.47 per 100 officers of all grades, and killed surgeons at the rate of 12.88 per 100. In the Mexican campaign of the French army, up to January 12, 1864, the expeditionary corps had lost 4 in 100 of officers, and 20 in 100 of its surgeons (Layet).

And for all these risks the reward is trifling. Beaugrand truly says : "Let physicians be devoted even to the sacrifice of life, as happens in epidemics and in the treatment of contagious diseases, so that they justify the adage, 'Aliis inserviendo consumuntur, aliis medendo moriuntur,' what will be their reward ? The ingratitude and forgetfulness of the patient, the eternal jokes of the story-tellers and the farce-writers, and finally the very last insult—the ass's kick, a newspaper penny-a-liner, a philanthropist of the bar-room and the stage-wings, will condescend from the height of his own moral incompetence to give them lessons in deontology ! "

In *tea-tasters* the nervous system becomes curiously affected. The number of experts in this business is small, and they taste enormous quantities of tea in the following manner: boiling water is poured upon the samples, and the decoction placed in small cups set in a row. The tasters, passing from one cup to another, sip the fluid, merely retaining it in the mouth long enough to form a correct judgment of its quality, and

then spit it out. The tea is never swallowed by them, and still the amount of thein absorbed by the mucous membrane of the mouth is sufficient to produce in time well-marked and well-recognized effects, viz., muscular tremblings, which increase until the occupation has to be given up. It is said that persons can rarely follow it longer than seven or eight years.

b. *Occupations involving over-use or abuse of the eyes.*

These are occupations in which minute objects have to be critically scrutinized, and frequently by artificial light. The objects, in order to be seen distinctly, must be brought quite near to the eye, and this necessitates a strong effort of accommodation. In this effort the eyeball is compressed somewhat by the muscles, and there is some congestion of its vessels in consequence. The congestion thus caused is increased by the use of artificial light, in which there is an excess of heat-rays and of yellow light-rays, both of which are trying to the eyes. The continued exposure to such conditions may cause hyperæmia of the retina, or of the choroid, with sparks and muscæ volitantes before the sight, slight lachrymation, a feeling of dryness of the inner surface of the lids, sometimes dimness of vision as if a mist were before the eyes, and quite severe neuralgia in the orbit.

Engravers, *lapidaries*, *watchmakers* and *seamstresses* are particularly subject to affections of the eyes due to the causes above mentioned. They also lead a sedentary life, and sit at their work in a very constrained attitude, with the body bent forward and the shoulders rounded, so that the thoracic movements are considerably interfered with. Accordingly they are all liable to phthisis, the cases of this disease among engravers and seamstresses being very numerous.

Engravers are somewhat subject to functional spasm of the fingers, and to anæsthesia of the skin of the hands and forearms, with occasionally atrophy of the interosseous muscles (Layet).

Watchmakers who repair watches have the nail of the right thumb considerably thickened and scaly from their manner of opening watches. The nails of the thumb and index of the left hand present, at the points where their borders correspond in approaching each other to hold delicate pieces, a worn appearance and almost complete destruction, produced by the constant rubbing of the file (Tardieu).

Seamstresses are sometimes poisoned by the stuffs with which they work. Numerous instances have occurred of arsenical eruptions in those who sewed green tarlatan, which is colored with arsenical salts (Prof. Nichols, of Boston, found 8.21 grains in one square foot of it), and itching with an eczematous eruption has been produced by tissues colored with the vivid aniline dyes. Silk thread is also sometimes soaked in the acetate of lead to increase its weight, and seamstresses, who frequently pass it through the mouth and bite it off with their teeth, have suffered from lead-poisoning in consequence.

The influence of sewing-machines on the health of women has been discussed by Gardner, Guibout, Vernois, Down, Decaisne, and Espagne, with

conflicting arguments and evidence. Guibout it was who asserted that the constant rubbing of the thighs in working the treadle produced sexual excitement, followed eventually by leucorrhœa, uterine congestion, and general debility with anæmia. His observations were made, however, upon a limited number of cases, and have not been supported. The most elaborate investigation was that of Decaisne, who examined in all 661 women. He found that young women, when they first began working with the machine, suffered very much from muscular pains and fatigue in the lower limbs, and often in the loins. Many were anæmic and dyspeptic, but not in greater proportion than other seamstresses. A large number had uterine disorders, but most of these confessed that they antedated their present employment. In short, the symptoms noticed or complained of were chiefly to be referred to their previous condition, their manner of living, diet, etc., or to unusual muscular exertion, and the latter generally disappeared to a considerable extent as the work became habitual. Much the same conclusions were arrived at by Dr. A. H. Nichols, who prepared an exhaustive paper on the subject for the Massachusetts Board of Health Report for 1872.

On the other hand, Layet says: "We think ourselves that the use of 'sewing-machines' has really an injurious effect only on professional seamstresses, who are especially devoted to this work in the great clothing-houses. But, after a first period of fatigue and excitement, to which succeeds an apparent habituation, we have always observed anæmia, dyspeptic and nervous troubles, and a marked enfeeblement of the innervation of the lower limbs, and we are not far from believing in a trophic change of certain regions of the spinal cord!"

Hirt considers it certain that the females who work with the sewing-machine suffer from disordered menstruation and sexual irritation. He quotes from Seligmüller a case of neuralgia, apparently due to the same cause, in a woman who had worked daily for four years sewing leather on a machine. Pains began in the tarsus of the right foot, and gradually spread, increasing in intensity, to the tuber ischii. When running the machine she was worse. The limb was not tender anywhere, electro-muscular contractility was decidedly lowered, and electro-cutaneous sensibility rather increased. Abandonment of the use of the machine alone afforded relief.

Writers in general agree that moderate work on the sewing-machine, for three or four hours a day, is rather beneficial to the health than otherwise, and it is only in large workrooms, where the girls work at the treadle for eight or ten hours, that evil results are apparent. It seems to me clear, therefore, that the chief cause of their troubles is fatigue, which, with their habits of life, food, associations, etc., fully accounts for the symptoms. As to the assertion of Guibout relative to the sexual excitement produced by the friction of the thighs, it is difficult to see why it should not occur in those who work three or four hours as well as in those who work eight or ten!

As the health of women is, on the whole, more important to the na-

tional vigor than that of men, special care should be taken to guard it. It is better, then, that sewing-machines should be worked by some other motor power than the muscles of women, and, when practicable, steam or water should be used. In almost all large establishments in New York the machines are worked by steam, and the only harmful conditions attached to the occupation are the confinement, the cramped position of the thorax, and the strain upon the eyes.

c. *Occupations exposing persons to over-use or abuse of the vocal organs.*

Those who use the voice a good deal, who are obliged by their occupation to speak in loud tones for hours at a time, and frequently in an impure atmosphere, are apt to suffer from the strain. Such persons are *actors*, *clergymen*, *public singers*, and *public speakers*. The most common disease produced is follicular pharyngitis, known as "clergyman's sore throat" (Green), due partly to the rapid evaporation from the mucous surface while the air passes over it when the mouth is open, and partly to actual mechanical irritation by the air-current. The vocal cords are sometimes implicated, and become congested and thickened, and occasionally there is even paralysis and resulting aphonia.

d. *Occupations exposing persons to over-use or abuse of certain muscles.*

Athletes, *prize-fighters*, *gymnasts*, *wrestlers*, etc., undergo at irregular intervals tremendous muscular exertion. As a result of these efforts, or of their usual irregular habits of life, or of both combined, such men are usually short-lived. Many of them have emphysema and heart disease (hypertrophy), and a large proportion eventually die of phthisis.

Persons who perform delicate operations with the fingers, which it has required long practice to learn and which are frequently repeated, suffer sometimes from what has been called "writer's cramp," because it was first noticed in penmen. It occurs in *writers* of all classes, *pianists*, *violinists*, *engravers*, *seamstresses*, *telegraph-operators*, and many others.

Musicians who play on wind instruments are very subject to emphysema (vesicular), on account of the strain brought to bear on the lungs by the thoracic muscles, while the expulsion of the air is hindered.

3. Constrained Attitude.

When persons are obliged to remain for a long time in one position, changes in nutrition or in functional activity are induced. When this fixed position is a standing one, without any alternation of muscular action by which the venous current in the lower limbs may be assisted, varicose veins are apt to result, and sometimes eczema and ulcerations. When the position during labor is a sitting one, hemorrhoids are caused, probably by the congestion of the hemorrhoidal plexus due to the contin-

ued warmth of the parts, and the costiveness attendant upon the lack of muscular exercise.

Printers, including *compositors* and *pressmen*, are generally pale and unhealthy in appearance. The characteristic anæmia is largely due to the bad ventilation of the rooms in which they work, to their lack of exercise, and, in the case of *pressmen*, to the heat of the press-rooms. *Compositors* frequently suffer from dyspepsia and diarrhœa, and also from bronchial catarrh and phthisis. According to Tardieu, twenty-five in one hundred die of the latter disease. Pneumonia is common among them, and is likely to be severe. Their habit of putting type in the mouth leads to the formation of cracks and fissures of the lips, and small tumors on the inner surface caused by the obliteration of the mouths of follicles, which sometimes ulcerate and form painful sores. Lead-poisoning is very rare among them, but there are occasional cases of "professional cramp."

Pressmen are said to suffer frequently from varices and heart disease.

Coopers, from the moisture of the rooms in which they work, are liable to contract bronchial and intestinal catarrh, and rheumatism and sciatica are common among them. They are liable to injuries of the hands and fingers, and wounds from splinters are apt to cause panaris. Serous bursæ in front of the knee (housemaid's knee) are frequent, as a result of the pressure of the knee againt the barrel to hold the staves in place.

Carpenters and *cabinet-makers* are extremely subject to varicose veins of the lower limbs. *Carpenters* frequently have hernia, and *cabinet-makers*, according to Layet and Koblank, are especially subject to varicocele. Injuries by their tools and splinters of wood are common among them, and they suffer more than the average population from phthisis and other lung diseases.

Shoemakers, as a rule, work under very bad hygienic conditions. The workrooms are badly ventilated—often small shops; they sit in a constrained position all day long, with body bent forward and shoulders rounded, and often extend their hours of labor into the night. Constipation and hemorrhoids are frequent among them; and Layet, in those who entered the army, often found eczema of the scrotum, which they all attributed to the dust from the leather. Lumbago and muscular pains in the legs are common, and there is a marked predisposition to phthisis. Corvisart and Mérat consider them especially liable to chronic gastritis and gastric cancer.

According to Tardieu, the pressure of the last on the breast produces, in spite of the leather apron, a depression of the thorax at the level of the chondro-sternal articulation of the sixth, seventh and eighth ribs, immediately above the ensiform cartilage. The sternum shows at this point a deep hollow, regular, circular, very clearly circumscribed, but not accompanied by general distortion of the thorax. The thigh on which the lapstone is placed shows a flattening of the skin, and especially of the hair-bulbs, which are obliterated so that the surface is smooth. According to Hirt, the peculiar sternal marks are common, but not constant, as Tardieu claims.

Hirt suggests that the solitary character of the work of shoemakers leads them to meditate a great deal, and occasionally produces great thinkers, like Jacob Böhme, Johann von Leyden, Hans Sachs, and others. This tendency makes many of them insane. And he quotes Halfort as saying that the *Meistersänger* of the middle ages were principally from the ranks of shoemakers, tailors, flax-weavers, etc., which may be called contemplative trades.

Tailors labor under much the same hygienic conditions as shoemakers. Their shops are small, often badly ventilated, and they sit all day cross-legged on a bench, bending over their work, with contracted chest and straining eyes. They are almost all anæmic, and furnish a large annual contingent of the deaths by phthisis. According to Hannover, this disease causes forty-eight per cent. of the deaths among them, but this proportion is probably much too high. Meditation at their work produces occasional insanity (Hannover). The use of the needle produces slight injuries of the fingers, which are sometimes followed by panaris. There are also cases of "professional spasm" among them.

Their attitude at work makes them round-shouldered, and the crossing of the legs on the bench develops bursæ over the external malleoli and the head of each fifth metatarsal bone. The circulation in the lower limbs is interfered with, and the muscles finally become flaccid and atrophied. There results a remarkable enfeeblement of the cutaneous sensibility in the thighs and legs, and a certain difficulty in walking. Sciatica and lumbar neuralgias are common.

Salesmen and *saleswomen*, who stand all day behind the counter, are subject to varicose veins of the lower limbs, and the women to uterine irregularities and anæmia. They frequently complain, too, of pains in the soles of the feet, the cause of which is not perfectly clear. Hirt has never been able to satisfy himself that pains of this character are ever caused by over-standing, but quotes from Marchant (Gaz. des Hôpitaux, 52, 1875), who relates the cases of three policemen who suffered from pains in their feet, and one of them had to give up his position on account of them. I have myself seen several cases, all in shop-girls, and have been disposed to attribute the pains to the tension of the ligaments binding the bones of the tarsus on the under side of the arch of the foot.

4. Sedentary Life.

Artists, clerks, lawyers, literary men, students, teachers, are liable to all the evils that flow from a life too much devoted to cerebral activity at the expense of other organs. While the vigor of the brain is undoubtedly increased by this exclusive and persistent activity, the vegetative functions of the body are carried on with less regularity and less certainty than in persons whose bodies are better taken care of. Trouble first shows itself in the digestive apparatus. Digestion is slow, with eructations and some uneasiness in the epigastric region, and the bowels are constipated. Many become dyspeptics, and the sluggishness of the portal circulation, aided perhaps by the warmth of the parts from long sitting, results in hemor-

rhoids. The debility that comes from their inactive mode of life leads many of this class to the use of stimulants, either tea, coffee, alcohol, or even opium. Where this practice is once begun, it is apt to become a habit not easily broken, and adds its potent influence to those already noted in breaking down the health.

Literary men in particular are apt to become insane. Even if not actual lunatics, so that they require the constant care of friends, they often suffer from hallucinations and fits of melancholy, which indicate nutritive disturbances in the brain. These symptoms, to be sure, are frequently the result of hereditary tendencies, but their development is hastened and expanded by their mode of life. A comparatively large proportion of men who lead sedentary lives suffer from urinary difficulties—generally gravel—as they grow old, and many of them finally die of apoplexy.

The habitual use of the eyes on minute objects, by artificial light, tends to produce asthenopia. In an analysis of 1,060 cases of this affection, by Dr. C. R. Agnew, the preponderance of persons of this class is very plainly shown. Thus, out of 380 male asthenopes whose occupations were noted, there were 154 students, 34 clerks, 29 lawyers, 18 bookkeepers, 6 teachers, 3 writers, and 3 editors—more than two-thirds of the whole number; and of 142 female asthenopes whose occupations were noted, there were 76 students, 19 teachers, and 2 writers—also more than two-thirds of the whole.

The proper mode of life for persons of sedentary habits would, of course, involve a more suitable apportionment of hours for bodily and mental exercise. The impairment of the sight should be guarded against by the correction of errors of refraction or accommodation, where they exist, and the shading of the eyes and use of tinted glasses when working by artificial light.

III.

Occupations involving exposure to mechanical violence.

Since the discovery and practical application of the power of steam, the multiplication of machinery has vastly increased the number of serious accidents in the civilized world. There are also certain occupations which have always involved more or less risk to those who follow them, and a third class in which the workmen are exposed to a change in the density of the medium in which they labor, so that this heading naturally includes mechanical violence due to *machinery*, that caused by *preventable accidents*, and that due to *variations in atmospheric pressure.*

1. *Occupations exposing persons to injuries from machinery.*

The persons who are most exposed to accidents of this kind are *factory operatives*, *machinists*, and *railroad employés.* In the first two classes the injuries are usually due to the carelessness of the person injured, whose dress or hair, or sometimes the limbs, are caught by running

belts, revolving shafts, cog-wheels, and the like. A large proportion of these injuries end in death, as they are of the most serious character, often causing lacerated wounds of the most horrible sort.

The ratio of deaths from this cause is not so large as to affect very much the death-rate of a community, and yet the number is very considerable. In Lille, from 1846 to 1852, for every 1,000 who worked with machinery driven by steam, principally in spinning-mills, there were twelve serious accidents. In England, where such records are kept with more accuracy than elsewhere, in 1875, out of 2,540,789 factory hands, 6,562, *i. e.*, 2.6 per 1,000, were injured. According to the United States census of 1870, 36 deaths were caused in that year by machinery in New York State, and 10 in Massachusetts, the total number of hands employed in manufacturing industries being respectively 351,800 and 279,380. This is a ratio of 1.02 in 10,000 for New York, and 0.35 in 10,000 for Massachusetts. In the whole United States there were 420 deaths by machinery out of a total of 492,263, or .85 in every 1,000.

The parts of the body most frequently injured are the upper limbs, as would naturally be expected, as they are most often in contact with the machinery. In France, according to Loiset, the relative frequency of injuries is 87 per cent. in the upper limbs, 7.5 per cent. in the lower, and 5.5 in the head and trunk. That they are largely due to sheer carelessness is shown by their greater frequency among children, who are not only ignorant, perhaps, but heedless of danger. The relative frequency of accidents according to age is as follows: 41 per cent. in persons under 15 years of age; 36.4 per cent. in those from 15 to 25; 13.1 per cent. from 25 to 40; and 9.5 from 40 to 60. The marked preponderance of injuries in the early ages is partly accounted for undoubtedly by the greater number of hands employed at those ages.

In order to prevent accidents as far as possible, the dangerous parts of machinery should be guarded by railings, boxes, or wire-netting, so that even the grossest carelessness should not have bad results. The clothing of persons who work with machinery should be close-fitting, and all flying aprons, sashes, etc., be discarded. Operatives should also be verbally admonished of the extent and character of the danger inseparable from their work when they first enter upon it.

Railroad employés are exposed to the danger of accidents, and also to various disorders of the nervous and circulatory systems, produced by the constant jarring to which they are subjected, and, in the case of engineers and firemen, by the vicissitudes of the weather.

Varicocele is very common among engineers and firemen—so common that Layet affirms that there is not one among them who does not early feel the necessity of wearing a suspensory bandage. According to Duchesne, their health is for the first few years of their service very much improved, and many of them gain flesh. But, to use his expression, they are, as a rule, tired out at the end of ten years, sufferers at the end of fifteen, and after twenty years can rarely continue in the service. In certain cases there is a notable diminution in the faculties of sight and

hearing, and dull, continuous, persistent pains in the lower limbs, with feebleness, rendering walking and standing upright tiresome and difficult. These symptoms he attributes to an affection of the spinal cord, produced by prolonged standing and the constant vibration of the locomotives.

Railroad accidents kill a considerable number of employés as well as of the travelling public. The number of such injuries is large in every country. Layet gives the following figures for France from 1854 to 1869:

	Killed.	Wounded.	Total.
Travellers	324	2,508	2,832
Employés	2,154	9,754	11,908
Others	991	1,076	2,067
			16,807

In England, on an average, 130 railroad employés are killed yearly, or 1 out of every 434 (Oesterlen). On the Breslau-Schweidnitz-Freiburg Railroad, in the five years from 1873 to 1877 inclusive, 1,614 men were employed on trains. Of these 21 were injured, *i. e.*, 13 in a 1,000, and 6 of them died of their injuries. The statistics on this subject are too incomplete in this country to give much information; but in 1870, out of 492,-263 deaths in the United States, 1,582 were reported as caused by railroad accidents.

Owing to their exposure to the weather and to strong draughts of air, engineers are liable to rheumatism and pneumonia.

2. *Occupations exposing persons to injury from preventable accidents.*

This heading might properly include a large number of occupations, but the most of them have been already mentioned elsewhere. *Lumbermen* are liable to injury from falling trees, colliding logs in the streams, etc., and also to acute pulmonary diseases and inflammatory rheumatism from exposure to the weather.

Quarrymen are liable to injuries of the most serious nature from falling stones, and are said to be subject to heart disease from the tremendous muscular efforts they are often called upon to make.

Roofers often have vertigo, and are sometimes compelled to abandon their trade in consequence of it. They furnish an unusually large proportion of accidental deaths. Lombard (of Geneva) states that 27 in 100 of the deaths among them are due to accident. From the habit of kneeling at their work, they sometimes have serous bursæ over the knee (housemaid's knee).

3. *Occupations exposing persons to injury from variations in atmospheric pressure.*

As all the functions of the human body are so related to each other as

to act harmoniously under the ordinary atmospheric pressure at the surface of the earth, when this pressure is diminished or increased an element of disorder is introduced and morbid phenomena appear. The first evidence of the effect of the changed conditions occurs in the ears, where the normal equilibrium of pressure on both sides of the membrana tympani is destroyed. After this the circulation and respiration are affected, and finally the nervous system.

Aëronauts pass with rapidity from a denser to a lighter medium. There is a diminution of external pressure, and consequently what may be termed an eccentric expansion of the fluids and gases of the body. The greater rarity of the air causes less oxygen to be inspired with every breath and the altered pressure changes the conditions of osmosis. The respiration therefore is hurried and there is often hemorrhage from the mucous surfaces and sometimes syncope. Ruptures of the membrana tympani not seldom occur.

Bert has recommended that aëronauts always take a supply of oxygen with them, in order to make up for the diminished proportion taken in with the breath, and the plan has been adopted in France with success.

Caisson-workers labor in compressed air, and the conditions are therefore the reverse of those just described. The inspired air contains more oxygen than is taken in with normal air, and the increased pressure causes a greater absorption of it by the blood. Peculiar symptoms are produced, which have been grouped and described as a special disease, termed "the caisson disease," by Dr. A. H. Smith. He defines it as "A disease depending upon increased atmospheric pressure, but always developed after the pressure is removed. It is characterized by extreme pain in one or more of the extremities, and sometimes in the trunk, and which may or may not be associated with epigastric pain and vomiting. In some cases the pain is accompanied by paralysis more or less complete, which may be general or local, but is most frequently confined to the lower half of the body. Cerebral symptoms, such as headache and vertigo, are sometimes present. The above symptoms are connected, at least in the fatal cases, with congestion of the brain and spinal cord, often resulting in serous or sanguineous effusion, and with congestion of most of the abdominal viscera."

These symptoms are more likely to occur in men of full habit, in those who drink, in those who are new to the work, and in those who enter the caisson with an empty stomach.

The morbid phenomena are attributed by Dr. Smith to the congestion of the internal viscera produced by the actual mechanical pressure on the surface of the body, and the slow recovery of tone by the distended capillaries after this pressure is removed, so that the effete blood produces disturbances of nutrition.

Paul Bert attributes the more serious symptoms to the disengagement of bubbles of nitrogen at the moment pressure is removed, the oxygen of the air remaining in combination in the blood. These bubbles of nitrogen, by his theory, produce what might be called aërial or gaseous emboli, and

in this way alter the nutrition of parts. But, as Dr. Smith pertinently observes, this bubble theory does not account for the facts that the symptoms are sometimes not developed until some minutes or even hours after leaving the caisson, and that persons, after habituation, obtain immunity from the disease. No person certainly could become accustomed to gaseous emboli !

To prevent as far as possible the evil effects of working in compressed air, Dr. Smith recommends that the same men should be retained during the whole work; that new hands should not work full time; that the hours of labor should be shortened as the pressure is increased, *i. e.*, the ordinary atmospheric pressure being fifteen pounds to the square inch, under a pressure of thirty pounds the men should work only half as many hours in the day; that men of wiry frame should be selected for the work; that the air-locks should be at the top of the caisson, so that the men may not have to climb after coming out; that sufficient time be allowed for coming out through the lock (three minutes for each additional atmosphere of pressure, and five on coming out); that the air in the caisson be kept as pure as possible; that the men never enter it fasting; that they put on extra clothing on coming out, and keep as quiet as possible for an hour afterward; that they avoid intoxicating liquors, sleep at least eight hours every night, never enter the caisson if sick, and report the very first symptoms for treatment. He also speaks favorably of a meat diet, and recommends the use of warm coffee.

Divers are exposed to the same dangers as the caisson-workers, but in a less degree.

Boiler-makers, especially those who work inside of the boilers, are very liable to become deaf from the incessant din. The deafness is undoubtedly caused by the continuous shocks imparted by the air-waves to the tympanum; but whether the resulting disease is wholly nervous, or is due in some degree to disease of the conducting apparatus, is uncertain. Dr. Roosa, in his work on Diseases of the Ear, states that the lesion in such cases must be sought for in the labyrinth, and is probably due to concussion of the fibres of the nerve in the cochlea and semicircular canals. But he adds that deafness from concussion, without an affection of the tympanic cavity, is very rare. Dr. Buck, in a personal communication to me, gives a similar opinion, and says that he has noticed, in a majority of cases that have come under his observation, decided milkiness and thickening of the membrana tympani, indicating chronic catarrh. Layet speaks of a case seen by him, in which the man could only hear in the midst of a tremendous din, and at other times complained of constant roaring in his ears. These symptoms, attributed by him to labyrinthine disease, seem much more like those of chronic catarrh of the middle ear.

It is rather singular that, although boiler-maker's deafness has been accepted as a fact, Hirt is sceptical regarding it, and considers it a very rare occurrence. It would in any event be advisable for the men who work at riveting boilers to stuff cotton in their ears, to diminish the force of impact of the sound-waves.

The following table is made up by combining two of Hirt's tables in one. Although statistics with regard to the effect of occupation on health are as yet meagre and in general unreliable, owing to various causes which are elsewhere considered, this table will be found more valuable than some, because in nearly half the list the total number of observations is recorded, and the proportionate frequency of each disease, so that, imperfect as these records are, they can serve as a basis for future investigation, and make a valuable addition to any facts obtained by other workers in the same field.

Trade.	Whole number treated.	Percentage suffering from									Mortality.		Average duration of life, in general.
		Phthisis.	Chronic bronchial catarrh.	Emphysema.	Pneumonia.	Other acute diseases.	Chronic abdominal diseases.	Rheumatism.	Heart disease.	Poisoning of occupation.	Among those taken sick.	In general.	
Agate-polishers	...	...	...	...	...	...	...	...	...	...	...	1.	45–48
Bakers	820	7.	10.9	1.9	8.5	32.9	21.7	11.9	5.2	...	8.4	1.7	...
Beltmakers	41	19.7	12.2		9.5	24 4	22.	12.2	...	...	10.	...	...
Blacksmiths	376	10.7	9.8	0.5	6.6	37.5	24.2	9.8	0.9	...	10.5	1.8	55.1
Bone-boilers, etc	...	6.	...	...	4.	25.	...	...	...	...	...	1.	64.
Brass-founders	32	31.2	9.3	...	15.9	18.6	12.5	12.5	...	...	...	1.5	60.4
Brass-workers	...	...	...	...	...	...	...	...	...	...	...	1.7	52.2
Brewers	178	11.2	5.1	1 7	4.4	39.3	20.7	16.2	1.4	...	11.1	2.	50.6
Britannia-workers	...	...	...	...	...	...	...	...	...	...	...	...	42.2
Brushmakers	171	49.1	28.	...	7.	12.2	3.7	...	...	...	13.9	1.6	...
Buckram-makers	...	...	...	...	...	...	...	...	...	...	...	...	63.1
Butchers	251	7.9	6.3	1.1	9.9	42.2	17.6	13.3	0.7	...	10.7	2.1	56.5
Button-makers	20	15.	25.	3.	7.	...	...	...	...	...	...	...	...
Cabinetmakers	1,214	14.6	10.1	3.9	6.	34.	18.4	10.1	2.9	...	11.8	1.8	49.8
Carpenters	304	14.4	6.5	6.9	6.9	29.2	14.4	17.4	4.3	...	10.6	...	55.7
Carpet-weavers	77	25.9	11.7	2.5	10.3	24.9	20.7	4.	...	...	14.3	2.3	...
Cartwrights	151	12.5	9.2	1.3	5.2	42.6	18.7	9.2	1.3	...	11.2	...	...
Catgut-makers	...	...	...	...	...	...	...	...	...	...	...	1.2	60–62
Cement-makers	...	8–10	15–17	...	4.	...	...	...	...	...	...	...	50.
Cheesemakers	...	...	...	...	...	...	...	...	...	...	...	1.2	...
Chimney-sweeps	76	6.5	22.2	2.6	10.5	39.4	5.3	13.5	...	...	9.	2.2	45.3
Cloth-shearers	48	10.4	12.3	12.3?	8.3	29.1	17.2	10.4	...	...	10.4	...	...
Cloth-weavers	...	7–10	6–8	2–4	3.	...	...	...	...	...	...	1–1.5	57.5–59
Coal-miners	39,879	0.8	16.4	0.9	4.7	...	13.8	...	...	...	...	1.9	...
Coal, workers in	49	2.	22.4	8.1?	14.4	31.3	12.7	7.9	1.2	...	7.	1.5	55.1
Coke-makers	...	...	...	...	...	...	...	...	...	...	...	1.5	...
Compositors	38	36.9	39.4	...	10.5	7.9	5.3	...	...	15.	...	...	...
Confectioners	180	11.6	8.	3.3	8.0	...	35.	18.	16.	...	15.	...	57.1
Coppersmiths	53	9.4	17.	3.7	3.7	39.6	15.	11.6	...	...	9.	1.8	48.6
Cotton-operatives	...	10.	...	...	...	...	...	...	...	...	...	3.5	47–50
Diamond-cutters	...	9.	...	40.	...	...	...	...	...	...	...	...	$35\frac{7}{12}$
Dyers	32	25.	9.3	...	6.2	21.8	15.6	12.8	9.3?	20.	12.5	2.5	63.7
Engravers	19	26.3	15.7	5.2	10.5	15.7	15.7	10.9	...	...	...	...	54.6
Fellmongers	112	23.2	10.7	2.7	8.1	23.3	16.9	12.6	2.5	...	12.	2.3	50.5
Fertilizer-makers	...	...	...	...	...	...	...	...	...	...	...	1.	51.
File-cutters	29	62.2	17.4	...	12.2	17.6	...	...	...	...	31.5	1.6	54.
Flax-operatives	...	...	...	...	...	...	...	...	...	...	...	2.5	...
Fullers	...	7–10	...	...	...	40–45	...	...	...	...	...	...	60.5
Gasmen	...	...	...	...	...	...	...	...	...	...	...	.5–1.	62–65
Gilders	60	10.	10.	...	...	...	...	...	...	...	...	...	53.8
Glass-cutters	...	35.	25.	3.	7.	...	...	...	...	...	...	...	42.5
Glass-makers	114	17.8	19.3	1.8	3.6	28.	14.9	10.5	4.1	10.	13.3	2.	57.3
Goldsmiths	...	...	...	...	...	...	...	...	...	...	...	...	44.
Gold, workers in	118	18.6	15 2	1.7	8.4	...	...	...	...	...	...	1.8	50.3
Gravediggers	...	...	...	...	...	...	...	...	...	...	...	1.7	58–60
Grinders	47	40.4	17.	...	2.1	17.	23.5	...	...	...	26.1	...	...
Gums, workers in	...	...	...	...	...	...	...	...	...	...		1.3	57.
Hatters	45	15.5	6.7	4.7	5.6	33.3	28.7	5.5	...	7.5	11.1	2.3	51.6
Horn, workers in	...	15.	...	...	...	...	...	...	...	...		...	...
Laborers, aniline works	...	14.	...	...	...	...	...	...	...	60 As. 15 An.	...	...	...
" arsenic-mines	...	11.	...	...	...	...	...	...	...	20.	...	1.6	47.
" artificial flowers	...	36.	...	...	...	...	...	...	...	15.	...		40.
" bleaching-works	...	...	...	...	...	...	...	...	...	...	...	1.2	52–53
" color-works	...	6.	...	...	...	...	...	...	...	12.5	...	1.2	48.7
" copper-forging	...	...	...	...	...	...	...	...	...	...	...		60.5
" day	4,688	15.1	11.	10.7	7.6	27.2	15.5	9.3	3.6	...	18.5	8.3	52.4

Trade.	Whole number treated.	Percentage suffering from: Phthisis.	Chronic bronchial catarrh.	Emphysema.	Pneumonia.	Other acute diseases.	Chronic abdominal diseases.	Rheumatism.	Heart disease.	Poisoning of occupation.	Mortality. Among those taken sick.	In general.	Average duration of life, in general.
Laborers, lead mines		12.?								6.		1.8	41.
" lead-smelting works		18.?								32.		1.8	41.
" liqueur factories												2.6	63.5
" match "		25–30	35.				40.				12.2	3.2	
" phosphorus works		25–30	22–25	6–8						2–3		1.5	
" quicksilver-mines		15.	20.		3.5					3–4		1.24	52.
" " smelting-works		25.?					35.			12.		.59?	44
" Schweinfürter-green works		25.								20.			
" silver-smelting w'ks		30.?								58.		3.06	42.5
" sugar of lead works		15.								21.		1.5	45.
" white-lead works		6.5	5.5	2.5						68.			
Lithographers	36	48.5	13.5	8.	5.4	16.2		8.4				.86	
Locksmiths	596	11.5	9.2	2.6	5.8	38.2	19.4	10.3	3.		15.	1.4	49.1
Machinists and stokers on rail roads												1.3	25.
Machinists and stokers on steamships												2.3	57.
Madder, workers in													60.
Masons	1,038	12.9	10.4	6.5	4.4	32.8	11.8	19.7	1.5		11.	1.5	55.6
Millers	256	10.9	9.3	1.5	20.3	18.7	20.3	15.6	3.4		13.2	1.7	45.1
Millstone-makers		40.											
Mirror-makers, male		25.					65.					2.8	48.6
" female		40.					80.					5.	36.2
Moulders			69.	17.3									
Needle-makers	80	12.5	15.	5.	10.	22.5	27.4	7.6			21.2		
Needle-polishers		69.6											50.
Oil, workers in												1.	64.
Painters	106	24.5	20.7	2.8	2.8	18.8	15.	10.5	4.9		17.9	1.5	57.5
" house	210	19.	6.7	2.4	7.5	26.8	23.	12.9	1.7		15.6		
Papermakers												1.2	37.6
Paraffin, workers in													60–62
Plasterers												2.	
Porcelain-makers		16.	15.	4.	5.	25.	25.	9.	1.				42.5
" -turners												2.	38.
Potters	170	14.7	14.7	2.9	5.3	31.7	20.	10.	.07	25.	12.2	1.8	53.1
Printers	134	21.6	15.6	2.9	5.2	29.8	14.1	7.8	3.	15.	12.2		54.3
Railroad employés												1.9	39.7
Refiners													70.
Rope-makers	111	18.9	12.6	5.4	5.4	36.	16.3	5.4			9.	1.8	42–45
Saddlers	234	12.8	7.5	2.5	5.	40.1	22.6	7.6	1.9		15.4	2.3	53.5
Salt-boilers													67.
" workers in												0.5-0.8	74.
Sandstone, workers in													45.
Scavengers												1–1.5	58–60
Serpentine, workers in												1.8	62⅜
Shoemakers	1,770	18.7	11.2	5.8	4.3						10.		
Sievemakers	19	42.1	10.5		15.7	26.3	5.4						
Slatemakers													50.4
Slate-quarriers													64⁶⁄₇
Smiths, in general	279	12.2	12.2	3.7	3.2	33.3	27.1	6.3	2.		9.2	2.3	
Soap-boilers	56	5.3	17.9	5.3	8.9	37.5	14.5	5.3					
Stonecutters	162	36.4	8.	8.7	8.7	19.8	5.6	12.8			21.5	2.7	36.3
Tanners	54	9.2	7.4	7.4	7.4	38.9	12.9	16.8			18.7	1.8	61.2
Tar, workers in			22.	5.	5.		15.	20.					60–62
Tin-founders										25.Pb. 10 As.			
Tinkers	141	14.1	18.4	1.5	4.9	33.3	13.4	10.	4.4		9.	2.7	47.7
Tin-platers												2.	
Tobacco, workers in	114	36.9	16.6	4.3	2.9	18.6	12.9	6.3	1.5	M. 15 F. 45	20.4	1.3	58.3
Turners	160	16.2	9.3	1.8	5.6		30.6	24.3	9.3	2.9	16.8	1.5	57.4
Type-founders	23	34.9	4.4		17.6	22.	13.2	7.9		35.			
Varnishers	68	25.	4.4	7.3	?	17.6	35.2	5.4	5.1		14.9	1.88	45.
Vine-dressers												1.9	52.7
Watchmakers	82	36.5	19.4	2.4	4.8	12.2	14.6	7.7	2.4		22.2	2.7	55.9
Weavers	59	25.	30.7	3.2	11.1	18.	12.					1.3	51.9
Well-diggers													58.3
Wigmakers	28	32.1	17.8	3.4	10.7	21.4	14.6					2.3	57.9
Wine-makers												1.9	52.7
Zinc-white, workers in		6.	12.	1.	6.								

SITUATION AND CHARACTER OF CALLOSITIES AND BURSÆ PRODUCED BY THE PROSECUTION OF VARIOUS OCCUPATIONS.

Occupation.	Callosities.					Bursae.
	On palm of hand.		On fingers.		On lower limbs.	
	Right.	Left.	Right hand.	Left hand.		
Banjo-players....	...	...	Tips...	Tips.		
Basketmakers....	...	...	...	Ulnar border 1st phalanx 3d finger.		
Brushmakers....	...	...	Dorsal surface			
Cabinetmakers ..	Base of thenar eminence.	Three running across palm transversely.	Inner border thumb and index.	...	...	Over sternum.
Carpenters......	Base of thenar eminence.	...	Dorsal aspect 1st and 2d phal. of index	Radial border of index.		
Chimney-sweeps.	...	...	...	...	Outer border of both knees.	Outer side of both knees.
Compositors.....	...	...	Thumb and index.			
Coopers.........	...	...	Inner border 3d, 4th & 5th	...	...	Over olecranon.
Drivers.........	Palm and ulnar border.	...	...	Radial border index and medius.		
Drummers......	...	...	Three first fingers.	Three first fingers.	On front of right thigh.	
Engravers.......	...	...	Distal part thumb and index.	Inner side thumb and index.		
Fencing-masters.	External border.					
Flax-hacklers....	...	...	...	Thumb.		
Floor-layers......	...	...	...	...	...	Both knees.
Furriers.........	...	...	Dorsal aspect 2d phalanx 3d & 4th fingers.			
Gilders..........	...	...	Whole external border of right index.	...	...	Anterior internal border of left forearm.
Gold-workers....	...	...	Dorsal aspect 2d phalanx 3d, 4th & 5th fingers.			
Guitar-players...	...	...	Tips...	Tips.		
Hair-dressers...	...	...	All fingers.			
Hand-organists..	...	...	...	...	Outside of right thigh.	Over right great trochanter.
Harp-players.....	...	...	Tips...	Tips.		
Hatters..........	Thenar and hypothenar eminences.	Thenar and hypothenar eminences.				
Locksmiths......	...	...	...	Thumb and index.		
Painters.........	...	...	...	Fold between thumb and index.		
Ragpickers......	...	...	...	...	...	Three in form of a triangle over sacrum.
Roofers.........	...	...	...	...	...	Both knees.
Ropemakers.....	...	...	Last phalanx thumb and index.	Last phalanx thumb and index.		
Seamstresses	...	...	...	Outer border thumb and index.		
Ship-calkers.....	At metacarpophalangeal folds.	...	...	Inner border thumb and index.		

Occupation.	Callosities.					Bursae.
	On palm of hand.		On fingers.		On lower limbs	
	Right.	Left.	Right hand.	Left hand.		
Shoemakers......	....	....	Fold between 2d and 3d phalanx of index.	Outer border thumb and index.	Anterior aspect middle of left thigh.	
Stone-breakers ..	....	....	Thumb and index.	....	....	Left knee.
Tailors..........	Broad ones of variable size.	....	Ring - shaped on thumb and index.	Thumb and index pricked.	....	Both external malleoli. Head of 5th metatarsals.
Tanners.........	Whole palm...	Whole palm in less degree.	Inner border 5th finger.			
Turners.........	....	....	Outer border little finger.	At metacarpo-phalangeal articulations.		
Violinists........	....	....	....	Tips.		
Watchmakers....	....	....	Thumb nail defective (opening watches).	Inner border thumb and outer of index		
Weavers.........	....	....	Dorsal aspect 2d phalanx 4th finger.	Dorsal aspect 2d phalanx 4th finger.		

BIBLIOGRAPHY.

General.

Ramazzini : De morbis artificum diatriba. Padua, 1713.

Gosse : Des maladies causées par l'exercice des professions. Paris, 1816.

Patissier : Traité des maladies des artisans et de celles qui resultent des diverses professions. Paris, 1822.

Benoiston de Chateauneuf : De l'influence de certaines professions sur le développement de la phthisie pulmonaire. Ann. d'hygiène publ. 1831.

Turner Thackrah : The Effects of the Principal Arts, Trades, and Professions on Health and Longevity. London, 1832.

Lombard : De l'influence des professions sur la durée de la vie. Paris, 1835. Ann. d'hyg. publ. 1836.

Villermé : Sur la durée trop longue du travail des enfants dans beaucoup de manufactures. Ann. d'hyg. publique. 1837.

Halfort : Entstehung, Verlauf und Behandlung der Krankheiten der Künstler und Gewerbetreibenden. Berlin, 1845.

Tardieu : Mémoire sur les modifications physiques et chimiques que détermine dans certaines parties du corps l'exercice de diverses professions, etc. Ann. d'hyg. publ. 1849–50.

Neufville : Lebensdauer und Todesursachen 22 verschiedener Stände und Gewerbe. Frankfurt a. M., 1855.

Vernois : De la main des ouvriers et des artisans, etc. Ann. d'hyg. publ. 1862.

Lévy : Traité d'hygiène. Paris, 1869.

Oesterlen : Handbuch der medicinischen Statistik. Tübingen, 1874.

Beaugrand : Dict. encyclop. des sciences méd.

Layet : Hygiène des professions et des industries. Paris, 1875.

Becquerel : Traité élémentaire d'hygiène. Paris, 1876.

Eulenberg : Handbuch der Gewerbehygiene. Berlin, 1876.

Oesterlen : Handbuch der Hygiene. Tübingen, 1877.

Proust : Traité d'hygiène. Paris, 1877.

Reichel: Die Sicherung von Leben und Gesundheit im Fabrik- und Gewerbe-Betreibe, etc. Berlin, 1877.

Sanders: Handbuch der öffentlichen Gesundheitspflege. Leipzig, 1877.

Oldendorff: Der Einfluss der Beschäftigung auf die Lebensdauer des Menschen. Berlin, 1877–8.

Arlidge: Address on Occupations in their Relation to Health and Life. British Med. Journal, Aug., 1878.

Lohman: Die Fabrikgesetzgebungen der Staaten des europäischen Kontinents. Berlin, 1878.

Uffelmann: Darstellung der auf dem Gebiete der öffentlichen Gesundheitspflege in ausserdeutschen Ländern bis jetzt geleisteten. Berlin, 1878.

Hirt: Die Krankheiten der Arbeiter. Breslau und Leipzig, 1871, 1873, 1875, 1878.

Special.

I.—Vapors and Gases.

Lorinser: Necrose der Kieferknochen in Folge der Einwirkung von Phosphordämpfen. Wien. med. Jahrb. 1845.

Gaultier de Claubry: Des allumettes chimiques avec ou sans phosphore. Ann. d'hyg. publ. 1859.

Wegner: Der Einfluss des Phosphors auf den Organismus. Virchow's Archiv. 1872.

Lewy: Die Berufskrankheiten der Quecksilberarbeiter. Wien, 1873.

Becourt et Chevallier: Mémoire sur les accidents qui atteignent les ouvriers qui travaillent le bichromate de potasse. Ann. d'hyg. publ. 1863.

Sonnenkalb: Anilin und Anilinfarben, etc. Leipzig, 1864.

Chevallier: De la benzine, de la nitrobenzine, et de l'aniline, etc. Ann. d'hyg. publ. 1866. De la fuchsine. Ann. d'hyg. publ. 1866. Note sur les ouvriers qui travaillent aux préparations de sulfate de quinine. Comptes rendus. 1858.

Greenhow: Brassfounder's Ague. Med. Times. 1862.

Delpech: Industrie du caoutchouc soufflé; recherches sur l'intoxication spéciale que détermine le sulfure de carbone. Ann. d'hyg. publ. 1863.

Dron: Des dangers de l'emploi de l'alcool méthylique dans l'industrie. Lyon méd. Feb., 1874.

Trébuchet: Du travail des peaux et autres résidus des boyauderies. Ann. d'hyg. publ. 1861.

Beaugrand: Recherches historiques et statistiques sur les maladies des ouvriers qui préparent les peaux en général et sur celles des tanneurs en particulier. Ann. d'hyg. publ. 1862.

Irritating Dust.

Pearson: On the Colouring Matter of the Black Bronchial Glands, and of the Black Spots of the Lungs. Philos. Trans., Vol. CIII. 1815.

Johnston: On a New Species of Phthisis Peculiar to Persons occupied in Pointing Needles. Mem. of the London Med. Soc., Vol. V.

Knight: On Grinder's Phthisis. North of Engl. Med. and Surg. Journal. 1830.

Chevallier: Des accidents auxquels sont exposés les couteliers, émouleurs, et aiguiseurs. Ann. d'hyg. publ. 1836.

Holland: Diseases of the Lungs from Mechanical Causes, and Inquiries into the Condition of the Artisans exposed to the Inhalation of Dust. London, 1843.

Melsens: Recherches chimiques sur les matières des mélanoses. Comptes rendus. 1844.

Fox Favell: On Grinder's Asthma. Trans. Provinc. Med. and Surg. Assoc. 1846.

Tardieu: Étude hygiénique sur la profession de mouleur en cuivre. Ann. d'hygiène publ. 1854.

Peacock: French-Millstone Maker's Phthisis. British Review. 1860.

Jordan: Maladies des ouvriers dans les fabriques d'acier. Ann. d'hyg. publ. 1864.

Coronel: De Diamantwerkers Te Amsterdam. Nederl. Tidjschr., Oct., 1865.

Rosenthal: Untersuchungen und Beobachtungen über Einwirkung pulverförmiger Substanzen, etc. Wiener Zeitschrift. 1866.

Kussmaul: Aschenbestandtheile der Lungen und Bronchialdrüsen. Centralblatt für die medicin. Wissenschaft. 1866.

Zenker: Ueber Staubinhalationskrankheiten der Lungen. Deutsch. Archiv für klin. Med. 1867.

Knauff: Das Pigment der Respirationsorgane. Virchow's Archiv. 1867.

Greenhow: Series of Cases Illustrating the Pathology of the Pulmonary Diseases frequent among Certain Classes of Operatives exposed to the Inhalation of Dust. London, 1865–69.

Meinel: Ueber die Erkrankung der Lungen durch Kieselstaubinhalation. Erlangen, 1869.

Merkel: Zur Casuistik der Staubinhalations-Krankheiten. Deutsch. Archiv für klin. Med. 1871.

Proust: De la pneumoconiosie anthracosique des mouleurs en cuivre. Mém. de l'Acad. de Méd. 1874.

Thouvenin: De l'industrie de soie. Ann. d'hyg. publ. 1846.

Potton: Recherches et observations sur le mal de vers ou de bassines, etc. Ann. d'hyg. publ. 1853.

Parent-Duchâtelet et D'Arcet: Mémoires sur les véritables influences que le tabac, etc. Ann. d'hyg. publ. 1829.

Ruef: De l'influence de la fabrication du tabac sur la santé des ouvriers. Gaz. méd. de Strasbourg. 1845.

Berutti: De l'usage du tabac, et de la santé des ouvriers, etc. Paris, 1846.

Jolly: Études hygiéniques et médicales sur le tabac. Paris, 1865.

Ygonin: Observations sur les maladies des ouvriers employés dans la manufacture impériale de la ville de Lyon. Lyon, 1866.

Kostial: Statistische-medicinische Studien über die Sanitäts-Verhältnisse der weiblichen Bevölkerung der k. k. Cigarrenfabrik in Iglau. Wochenblatt der k. k. Gesellsch. der Aerzte in Wien. 1868.

Tracy: Report on Tobacco and Cigar Manufactories, in N. Y. Board of Health Report for 1872.

Emerson and Tracy: On the Manufacture of Cigars in Tenement Houses, in N. Y. Board of Health Report for 1874–5.

Schuler: Die glarnische Baumwollindustrie und ihr Einfluss auf die Gesundheit der Arbeiter. Deutsch. Vierteljahrschr. f. öffentl. Gesundheitspflege. 1872.

Mahier et Chevallier: Mémoires sur les ouvriers qui travaillent les coquilles de nacre de perle. Ann. d'hyg. publ. 1852.

Gussenbauer: Die Knochenentzündungen der Perlmutterdrechsler. Langenbeck's Archiv für klin. Chirurgie. 1875.

Poisonous Dust.

Chevallier: Essai sur les maladies qui atteignent les ouvriers qui préparent le vert arsenical, etc. Ann. d'hyg. publ. 1847.

Pietra-Santa: Existe-t-il une affection propre aux ouvriers en papiers peints qui manient le vert de Schweinfurt? Ann. d'hyg. publ. 1858.

Vernois: Mémoire sur les accidents produits par l'emploi des verts arsenicaux, etc. Ann. d'hyg. publ. 1859.

Hamilton: On Manufacturing Establishments where Lead and Arsenic are used. N. Y. Board of Health Report. 1872.

Draper: Arsenic in certain Green Colors. Mass. State Board of Health Report. 1872.

Chevallier: Recherches sur les causes de la maladie dite colique de plomb chez les ouvriers qui préparent la céruse. Ann. d'hyg. publ. 1836.

Tanquerel Desplanches: Traité des maladies saturnines. Paris, 1839.

Chevallier: Notes statistiques sur les ouvriers atteints de la colique de plomb, traités dans les hôpitaux de Paris. 1840.

Tardieu: Rapport sur la question de la suppression de la fabrication et de l'emploi du blanc de plomb, in Recueil des travaux du com. consult. d'hyg. publ. de France. Paris, 1872.

Chevallier: De l'intoxication par l'emploi du nitrate acide de mercure chez les chapeliers. Ann. d'hyg. publ. 1861.

Lewy: Die Gewerbskrankheiten der Hutmacher. Wiener medicin. Wochenschrift, XIX. 25. 1869.

Chevallier: Note sur la santé des ouvriers qui travaillent le cuivre. Ann. d'hyg. publ. 1843.

Blandet: Mémoire sur la colique de cuivre. Bull. de l'Acad. de Méd. 1846.

Chevallier: Note sur les ouvriers qui travaillent le vert-de-gris. Ann. d'hyg. publ. 1847.

Toussaint: Kupfer kein Gift. Casper's Vierteljahrschr. XII., p. 228. 1857.

Pietra-Santa: Mémoire sur la colique de cuivre. Comptes rendus. 1858.

Perron: Des maladies des horlogers produites par le cuivre et l'absorption des molécules cuivreuses. Ann. d'hyg. publ. 1861.

Harley: Copper Colic. Lancet, Aug. 5, 1863.

Bouvier: Observation d'un cas de colique métallique observé chez un ouvrier employé dans une fabrique de blanc de zinc. Comptes rendus. 1850.

Casper: Ueber Nothsucht uud Päderastie, etc., in Vierteljahrschr. für gerichtliche Medicin. 1852.

Tardieu: Etude medico-légale sur les attentats aux mœurs. Ann. d'hyg. publ. 1858.

Numantius: Studien über Mannmännliche Geschlechtliebe, in Forschung über das Räthsel, etc. Leipzig, 1864.

II.

Tissot: De la santé des gens de lettres. Paris, 1767.

Benoiston de Chateauneuf: De la durée de la vie chez les savants et les gens de lettres. Ann. d'hyg. publ. 1830.

Catala: Essai sur l'hygiène des gens de lettres. Paris, 1857.

Parent-Duchâtelet: Recherches sur la véritable cause des ulcères qui affectent fréquemment les extrémités inférieures d'un grand nombre d'artisans à Paris. Ann. d'hyg. publ. 1831.

Gardner: The Hygiene of the Sewing Machine. American Med. Times, 1860.

Decaisne: La machine à coudre, et la santé des ouvrières. Ann. d'hyg. publ. 1870.

Nichols: Sewing Machines. Mass. State Board of Health Report. 1872.

Diday: Transmission de la syphilis chez les ouvriers souffleurs de verre. Gaz. méd. de Lyon. 1852.

Tremenheere: Report on Grievances of Journeymen Bakers London, 1862.

Hamiltou: On the Liability of Car-drivers to Certain Forms of Disease. N. Y. Board of Health Report. 1873.

Adams: The Health of the Farmers of Massachusetts. Mass. State Board of Health Report. 1874.

Agnew: A Preliminary Analysis of 1,060 Cases of Asthenopia. New York, 1877.

III.

Duchesne: Des chemins de fer et de leur influence sur la santé des mécaniciens et des chauffeurs. Paris, 1857.

Pietra-Santa: Chemins de fer et santé publique. Paris, 1861.

Tardieu: Accidents des chemins de fer. Ann. d'hyg. publ. 1871.

Pol et Watelle: Mémoire sur les effets de la compression de l'air, etc. Ann. d'hyg. publ. 1854.

Guérard: Note sur les effets physiologiques et pathologiques de l'air comprimé. Ann. d'hyg. publ. 1854.

François: Des effets de l'air comprimé sur les ouvriers travaillant dans les caissons servant de base aux piles du pont du grand Rhin. Ann. d'hyg. publ. 1860.

Foley: Du travail dans l'air comprimé, etc. Paris, 1863.

Jaminet: Physical Effects of Compressed Air. St. Louis, 1871.

Paul Bert: Recherches expérimentales sur l'influence que les changements dans la pression barométrique exercent sur les phénomènes de la vie. Comptes rendus, 1871-2-3.

Smith: The Effects of High Atmospheric Pressure, including the Caisson Disease. Brooklyn, 1873.

HYGIENE OF CAMPS.

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HYGIENE OF CAMPS.

SECTION I.

ON CAMPS IN GENERAL.

The Regular Army of the United States is so reduced in size as to require hard service on the part of its components to accomplish its every-day work creditably. In the event of war—our Indian troubles are seldom dignified by that name, although the troops engaged in the effort to suppress them find it very real war indeed—with a foreign power, it would be unavailable as an instrument of offence or defence. But it would serve as the nucleus on which the martial spirit of the country would crystallize into a solid whole capable of being hurled with effect upon the enemy.

Our citizens form the mass of the army when on its war-footing, and the ranks of the profession in civil life furnish its medical staff. Viewing his professional brethren therefore as possible army surgeons, the writer has preferred to discuss the principles of *Camp Hygiene* from the military standpoint, as it oversees the whole field and includes all temporary settlements such as summer resorts, refugee camps, etc., in which the civilian is more especially interested.

The popular idea connects the chief duty of the army surgeon with the battle-field and its scenes of suffering and death. This is natural, the mind being attracted by the sensational and catastrophic: the defiant shouts of opposing lines, the rattle of musketry, the gallant charge amid the thunder of artillery, with death stalking red-handed from front to rear, contribute to the popular battle-picture; and in this the services of the surgeon can be idealized. But, while battles are not of every-day occurrence, death breathes his venom over the camp in a steady stream, making the weak fall and the strong weak, should the hygienic government fail to counteract its influence. There is no noise in this conflict, and, though more deadly than the other, it seldom attracts the public attention.

Even the professional mind is liable to run from military surgeon to military surgery, forgetting, in the "fine field for operation," that for *one* soldier who dies in or after the battle, there are *two* who fall victims to disease; and for *one* who is discharged for disability from wounds, there are

three who linger out a shortened and disabled existence as the wounded in the battle with disease.

The statistics of our late war give as the number

Killed	44,238	93,443
Died of wounds	49,205	
Died from disease		186,216
Discharged on account of wounds		48,374
Discharged on account of disease		136,584

It is the surgeon's duty to treat the individual cases; but it is his greater duty, as guardian of health, to prevent their occurrence.

Military hygiene is by no means a product of our advanced civilization. Its principles were known to the Romans, who were guided by them in laying out their camps, in the selection and change of site, in the protection of the soldier from injurious influences, and in the establishment of hospitals for his treatment when prostrated.

But the wave of barbarism which swept over Europe on the fall of the empire left not camps only, but the nations of the world, a prey to plagues and pestilence.

Gradually science revived, and, struggling with disease, gained steadily generation by generation until to-day, when theorists can plan hygienic governments in which disease has no foothold, and practical men, following their plans as closely as the trammels of custom and the condition of things will permit, have effected much good by their arrangement of the new and adaptation of the old.

But the progress has been slow even in these later times. Dr. Jackson condemned double-tiered bunks in the early part of this century; yet Dr. Billings, writing in 1870, says:[1] "A point in which our service is behind the age, and an evil which should be put an end to with the least possible delay, is the use of the double bunk, usually aggravated by placing it in two tiers, and even, as at Fort Buford, in three." Attention thus specially called to the faulty sleeping arrangements had the desired effect of banishing the emigrant-ship bunk from our barrack-rooms.

Since the sickness and mortality in 1855, during the Crimean campaign, public opinion has become interested in the condition of the soldier and his camps, and it may be safely said that the greatest advance has been made during the past quarter of a century.

The ground, once acquired, is held by nations which sustain a large standing army. But what *we* gain in one war we lose before the next. With us, on account of deficient drill, discipline, and practical experience of camp-life, the uprising of the people for war purposes would be followed by a larger ratio of sickness and death in our camps than military nations would experience in theirs under an equally sudden call to arms.

The perfection of the military camp requires the united action of so many—knowledge and discipline on the part of officers and men, efficiency

[1] Circular No. 4: Report on Barracks and Hospitals, p. xvi., Washington, 1870.

of supply departments in the face of unforeseen emergencies, co-operation of those at home with those in the field, available resources in the treasury and disposition to use them—that it would be matter for surprise if the country worked its theoretical knowledge into practical forms without failure from the start. Observe the diminishing sick-rate in our armies during the first three years of the war. The wounded are not included.

1st	year,	2,983	cases per 1,000,	with	a strength	of	279,371	men.
2d	"	2,696	"	"	"	"	614,325	"
3d	"	2,210	"	"	"	"	619,703	"

The system of military camping demands attention, in the first place, that the reader may have clear ideas of what constitutes a camp. A body of men have to be sheltered and fed, and if their stay be prolonged in the locality for more than a few hours, trenches or sinks have to be provided for the deposition of their excreta. Shelters, kitchens and sinks make the camp, and the same principles govern their arrangement, whether the body of men be a small detachment, a company, a regiment, or a series of regiments organized into brigades, divisions, and corps—in fact, an army.

We can hardly be said to have a regulation camp in our service. We have practically changed our tents, modified our tactics, and gained much field experience since the Regulations of 1861, reprinted in 1863, paced off the distances for the laying out of military camps. Yet, as all our camps are based on these Regulations, they are necessarily similar in their main points.

The regiment of infantry, as at present constituted, consists of 10 companies, each of 3 officers and 54 men, making, with the field and staff officers, non-commissioned staff and servants, a total of about 600 men.

The width of its camp depends on the length of the line-of-battle front which the command presents. The officers and five men of each company have positions which do not add to the frontage. The remaining 490 men are in a double line, offering a front of 245 men, which, at 22 inches per man, gives the line of battle, or color-line, a length of 150 yards, or 15 yards to each company. To this, the main factor in determining the width of camp, must be added the interval of 24 yards between regiments on the line, which gives to each regimental camp a margin of 12 yards on its right and left.

The 600 men have therefore a front of 174 yards for their camping-ground.

The depth is specified in the Regulations in paces from the color-line. The pace is the average step of the soldier—28 inches.[1] Ten paces in rear of the color-line, marked C on Fig. 1, are the tents of the men, which

[1] Gordon, in his "Army Hygiene," London, 1866, gives the pace as thirty inches, that being the regulation step of the British soldier. Hammond confuses it with the yard, where, in his Treatise on Hygiene, p. 459, he says: "The latrines should be situated at least 150 yards from the tents. This is the distance required by the General Regulations of the Army," etc.

have to be pitched on a line perpendicular to it, as the frontage per company is insufficient to admit of having them parallel. Each company is

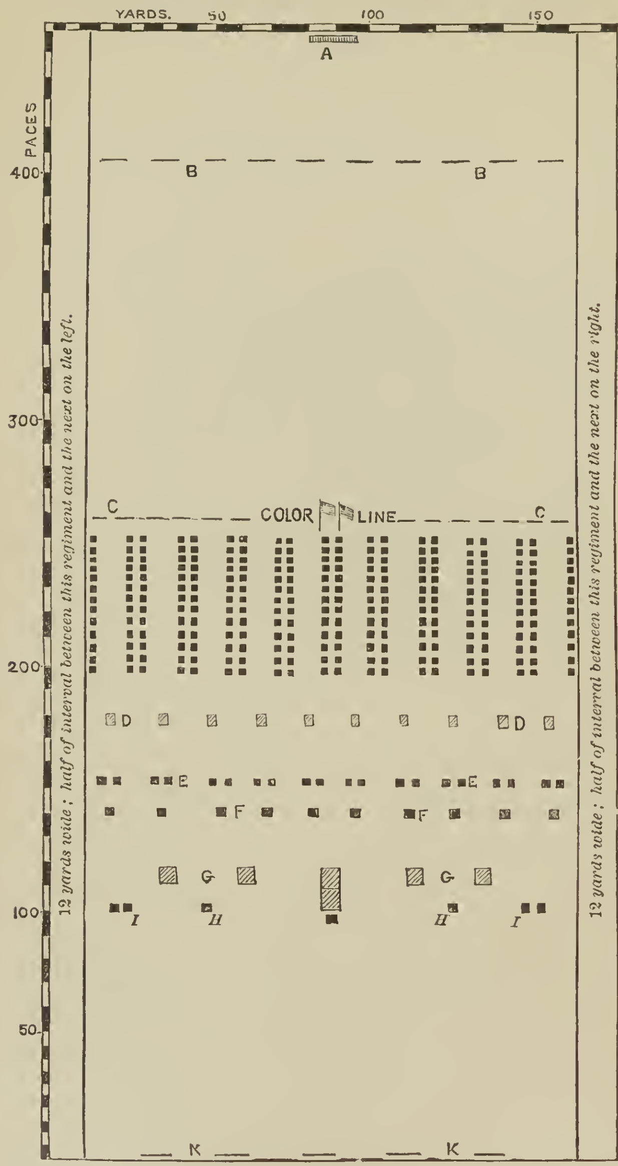

FIG. 1.—Regiment of infantry camped on its line of battle: Frontage, 174 yards. Depth, 358 yards or 460 paces. Area, 62,292 square yards. Occupation, 600 men. Superficies per man, 104 square yards.

Scale, 60 yards or 77 paces to the inch.

disposed in two files with a street between, their tents or huts opening on the street. There are thus ten streets, separated by nine double rows of

tents, the streets on the left and right being each completed by a single row. Each row contains, if shelter-tents are used, about thirteen tents, which should be pitched so as to give the streets a length of fifty paces and a width of nine yards.

When needful, for military reasons, to narrow the frontage of the camp, it should be done at the expense of the width of the streets. The Regulations, however, prescribe a street-width of five paces, or about four yards, as the maximum of condensation. Further narrowing of front must be effected by camping in "columns of division," where each company is arranged in a single row along the side of one of five streets—the streets being kept wide by diminishing their number and narrowing of front, in part compensated by increase of depth.

The company kitchens, D, are in line parallel to the color-line and 20 paces back of the rear rank of tents. The company officers are quartered on the line, E, 20 paces in rear of the kitchens, and on the accompanying plan a depth of 15 paces is allowed for their tents, servants' quarters, and kitchens, F. Farther to the rear, 20 paces, are the quarters, G, of the field and staff of the command, and behind them, 20 paces, their kitchens, H, and the tents, I, of the non-commissioned staff. Officers' sinks, K, are 100 paces beyond, with regimental wagons, if any, parked in the interval. The sinks of the men, B, are 150 paces in front of the color-line, and the advanced guard, A, 50 paces in front of the sinks.

Summing up these figures, it is found that the 600 men have a depth of 460 paces, or 358 yards for their camping-ground, yielding them an area of 62,292 square yards, or a superficies per man of 104 square yards.

When this camp is compressed by narrowing its company streets to 4 yards, the utmost extent of crowding countenanced by the Regulations, 50 yards are lost from its width, leaving it with a frontage of 124 yards, the depth remaining unaltered, and giving a superficies per man of 74 yards.

The cavalry regiment consists of 12 companies, each numbering 3 officers and 70 men, which, with the field, staff, non-commissioned staff, and servants place in round numbers 900 men in its camp. The regiment is divided into three battalions of 4 companies. As this arm of the service requires so much ground for its evolutions, its camps are by no means so crowded as are those of the infantry. The formation in line is a single rank, each company presenting a front of about 70 yards, 1 yard being allowed per horse. The front comprises also intervals of 8 yards between companies, 16 yards between battalions, and 60 yards between regiments. The camp width of such a command would therefore be about 1,000 yards—so wide, indeed, that the tents of the men can be pitched parallel to the battle-front instead of perpendicular, as in the infantry. The picket-line, to which the horses are fastened, is the starting-point in laying out the camp. In front of it, 20 paces, is the line of company tents opening toward the horses; 20 paces forward are the kitchens; 150 paces beyond are the sinks, and 50 paces farther the advanced guard. To the

rear of the picket-line, 30 paces, are the quarters of the company officers, and from these 30 or more additional paces bring us to those of the battalion commanders, 30 or more to the tents of the commanding officer and staff, and 100 to the sinks.

These figures give a depth of 430 paces or 334 yards, making the area of camp 334,000 square yards, and furnishing each man with a superficies of 371 yards.

With the regiment encamped in column of companies at full distance, the front remains as when in line, but the depth is increased by pitching the company tents and ranging the horses perpendicular to the line of battle.

But when such an extended front cannot be afforded, the command may be camped on the ground it occupies when in closed column of companies, that is, with 12-yard intervals between companies, and 70 yards, or a company front, between battalions. These distances, with the inter-regimental interval of 60 yards, and 36 yards for 12 ranks of horses at 3 yards per horse, give a front to the camp of 414 yards; but its depth is greater than that of the line-camp by about 100 yards, which have to be allowed for the perpendicular arrangement of the company quarters. In this camp each man has a superficial area of 200 yards.

The battery of artillery on a war-footing consists of 6 guns—two of which constitute a section, 5 officers, 150 men, and about 120 horses. It occupies a front of 100 yards, and is usually arranged with guns in front and caissons in line behind them. The tents of the men are in three files or rows, each in rear of its section of the battery, and perpendicular to the line of caissons. Horses are ranged parallel to the tents of their section and on their left. Officers' quarters are in rear and on the right, company kitchens in rear and on the left, of the files of tents. The officers' sinks are at the usual distance behind their quarters, and the men's in rear of the company kitchens, with the battery-wagon, forge- and forage-wagons intervening. The ground covered measures 100 yards by 230, giving 143 square yards per man.

Small commands are usually accompanied by their baggage-wagons or pack-mules and their hospital accommodations, which encamp in their immediate rear, like the forge- and forage-wagons of the artillery; but when troops are aggregated in larger masses, the wagon-trains and hospitals are brigaded, march with a specially detailed escort, and encamp well to the rear and wholly disconnected by distance from the camps of their regiments on the line.

Since the Crimean war much attention has been drawn to overcrowding of surface in military camps. Parkes and Hammond both lay stress on this point, and quote figures from the report of the Royal Sanitary Commission which give an exaggerated idea of the condition of things. It has been shown that in towns the proportional sick and mortality rates increase with the density of the population, and camps being proved to have a density exceeding that of our most populous cities, disease in them follows as a matter of consequence. Thus—

East London has a density of	175,816	per sq. mile	=17·6	sq. yds per cap.
Liverpool parish	" 138,224	"	=22·4	"
Manchester	" 100,000	"	=30·9	"
Philadelphia, Pa.,	" 45,000	"	=68·8	"

while the English regulation camps, which practically do not differ from those above described, are represented as having a density of from 347,000 per sq. mile, equalling 8·9 sq. yds. per man, to 664,000 per sq. mile, equalling 4·7 sq. yds. per man.

But the cases are not parallel. In London, which gives 17·6 yards per head, every street, alley and square is included in the superficies, while in the 4·7 to 8·9 per soldier only the areas of the company tents and the streets between are computed. These areas are an important item in another connection—the shelter and air-space of individuals; but when brought into the question of camp surface, they are liable to beget erroneous ideas. Such excessive crowding within the lines of an army would of necessity be productive of disease. Putting aside organic emanations, no man could expect to inhale a thoroughly oxygenated breath. Hence, if it be accepted as a fact that this condition exists when troops are encamped on their battle-front, disease must be admitted as the natural and inevitable consequence. But if it be premised that the surface occupation is such as is consistent with robust health, other circumstances being favorable, the occurrence of disease must be regarded as indicating some point overlooked in the hygienic government, which must be discovered and remedied. Nor can stress be laid on the evils of camp-crowding in its general sense without unduly exalting the benefits of elbow-room and the fresh air of the country. Yet there are squatters' camps in the West, with but half a dozen huts to as many square miles, in and around which camp diseases can be as deadly, in proportion to population, as within the lines of an army.

But, instead of expressing the occupancy of a camp on an estimation of the company areas, it would seem proper to debit the men of a given regiment with as many square yards as the regimental camp-ground can afford them. This, as shown above, is 104 yards, or, in the compressed camp, 74 yards per man.

Even this estimate is too small when the area or moving space per man of an army is under consideration; for, as the soldier has less space—his half of a shelter-tent or bunk in a squad hut—as an individual than he has as a member of the company, and less in the latter instance than as one of the regiment, so, by virtue of interspaces between brigades and larger intervals between divisions, the area per man of an army, as represented by the square mile of occupation, is correspondingly greater.

Let a command be supposed consisting of two divisions, each of which has fifteen regiments organized into three brigades and supported by two batteries. Its strength is 18,620 men. To effect greater condensation in their camps, let one division be placed on the line and the other in reserve, with the regiments on their minimum of front. The regimental front is

124 yards, space between brigades for battery 100 yards, and interdivisional interval at either end of the line 50 yards, making a frontage for the camp of 2,160 yards.

FIG. 2.—Camp of an army corps in two divisions—the regiments on their minimum of front. Length of camp or frontage, 2,160 yards. Depth, 1,566 yards. Strength present, 18,620 men. Superficies per man, 182 square yards. Density per square mile, 17,020 men.

The depth of the regimental camp has been found to be 358 yards. One hundred yards' space to the rear must be given to brigade commanders,

and 200 yards to division headquarters. An interval of at least 50 yards exists between the last and the advanced guard of the reserve line. Army headquarters are 200 yards in rear of the second division.

These figures give 1,566 yards as the depth of the camp, and 182 yards as the superficies per man. This camp is shown in Fig. 2, where A is army headquarters, B those of the divisions, and C of the brigades; *a* is advanced guard of the regimental lines, *b* men's sinks, *c* color-line, *d* area of men's quarters, *e* company kitchens, *f* quarters of company officers, *g* field and staff, *h* officers' sinks—all of which have already been shown on a larger scale.

When the regiments occupy their full line of battle, the additional frontage would increase the space to 245 square yards per man. The former estimate gives a density per square mile of 17,020, the latter 12,643; and these are the figures on which comparison with town densities ought to be instituted. But it must be remembered that this is a crowded camp, such as would only be found in the immediate presence of the enemy. In more permanent quarters, while recuperating or wintering, it is seldom that the density would be so great.

While statistics show that disease and death bear a relation to density in cities, there is little occasion to lay the occurrence of epidemic disease on the mere fact of crowding their superficies to this extent. The city of Portland, Maine, with its 1,666 acres and 38,000 inhabitants, has a density per square mile of 14,612. It is favorably situated in a hygienic point of view, being cut off by the sea on three sides from other communities, with an elevated site, good drainage, dry subsoil, and pure water-supply. Its diseases, outside of those from climatic influences and individual cachexies, must be imported or depend on inefficient police, errors of alimentation, or local crowd-poisoning in tenements. So, in the divisions supposed, if camped on such a site as Portland promontory, their freedom from disease ought to depend on exclusion of infection from without, protection from climatic influences, efficient superintendence of commissariat supplies, disposal of excreta to prevent contamination of soil and water, and hygienic supervision to counteract the tendency to localized crowding or faulty sheltering.

There is nothing in the fact that from ten to twenty thousand men are aggregated on the square mile to imply the existence of disease in the camp, any more than in the city; only that increased vigilance is needful in the former to counterbalance the lack of sewerage. Instances are numerous in the history of armies, and in the writer's personal experience as Medical Inspector of the Second Army Corps, where veteran regiments have camped on favorable sites during their five or six months of winter quarters, with the sick list a blank but for trivial cases of accidental injury and climatic or dietetic disease.

Density of population to the extent existing in military camps has no direct causative influence on the inception of disease. There seems to be a tendency to confuse the primary crowding—if it can be said to exist—with the secondary contaminations, and to view the preventable evils

springing from the latter as the inevitable consequences of the former. But the distinction is a practical one, for on it hinges the whole subject of military hygiene, its underlying principle being the preventability of camp diseases.

SECTION II.

ON THE SITE OF CAMPS.

The selection of the camp-site is perhaps the most important point in military hygiene, although it is difficult to assign importance to any one circumstance where each is essential in its particular way. All points bearing on the hygiene of camps are of moment, as the strength of all parts of a line of battle are essential to its integrity. The camp is surrounded by enemies in the form of disease, and a break in the line of its hygiene, whether on the front guarded by alimentation, shelter, selection of site, water-supply, general or personal police, is disastrous to the whole. But the site has this importance, that, in the event of its insalubrity, no amount of care in the sanitary government can protect from evil consequences. Disease may be lessened, but cannot be prevented.

"Wood, water, and grass" are the requisites of a camp-ground, in the language of the military officer; but the hygienist has in addition a *sine quâ non*—dryness of soil—which must be given up only in the face of the most imperative military necessity. Were the maxim changed to "a dry soil and neighborhood," with the other requisites qualifying it, the sick-rate of camps would be materially lessened. Statistics are unavailable to sustain this statement, as the noxious effects of dampness in site cannot be separated from those of dampness as a climatic condition; but when it is remembered that all malarial disease depends for cause on moisture in the soil of camp and its vicinity, the importance of dryness can be appreciated.

Unfortunately, the choice of site on active service is often narrowed down to a nullity. Expeditionary columns must encamp near their line of march, no matter what the character of their camping-ground. They must camp near water, and, in our southern territories especially, it frequently happens that proximity to water and exposure to malaria are synonymous terms. Again, a swamp on the line of battle or around a besieged city, if passable to troops, must be guarded as carefully as the most healthful ground. Yet in these cases the driest site consistent with military necessity must be selected for the establishment of camp.

But, in the formation of camps for the organization or recuperation of troops, or for their passive occupation, as in winter quarters, the dry site and dry vicinity ought to be considered imperative.

Moist soils, under their most favorable aspect, induce catarrhs, quinsies, and other internal inflammations, develop phthisical and rheumatic

tendencies, and, by depressing the vitality of the system, render it an easier prey to other morbific agencies. But it is too often the case that moisture in the soil gives rise to directly poisonous emanations.

The soil consists, in general terms, of certain rocks, supporting layers of their detritus, and covered over by a surface more or less thick of this same detritus commingled with the remains of previous generations of vegetable life. These organic matters, by the agency of the heat, air and moisture, which permeate the soil, undergo fermentative changes, which eventuate in the resolution of their complex principles into such simpler forms as carbonic acid and ammonia needful for the sustenance of existing life. So nature completes her round, evolving from the dead tissues of former generations the pabulum of the living present.

Vegetation is luxuriant not in proportion to the organic matter in the soil, but to the activity of the fermentative changes taking place in it. There are arid plains in the West, barren but for scattered sage-brush and an occasional cactus, which are rich in organic remains, and require only moisture to transform them into fertile fields. Ten years ago the fertile settlement of Phenix, in Central Arizona, was formed on such a plain, by turning the waters of Salt River into one of the old Aztec ditches and flooding the country.

Air is constantly present in the interstices of the soil. Heat and moisture are climatic or local accidents which may or may not coincide in a given locality. Moisture may be present, but without a certain temperature there is no great development of vegetable life. Heat, in like manner, may be present, but without moisture there is no fermentation.

The changes which take place in the organic matter are insufficiently studied, but among the products is one which is recognized as malaria. Its effects are familiar, and many of its habits so well understood that we have argument for receiving it as a gaseous or vaporous body evolved from the soil, or, if solid, so minutely divided that its particles are readily carried upward by the ascensional force of evaporation. The living vegetation has nothing to do with its production or evolution, but would rather seem to be concerned in its destruction. Indeed, it scarcely appears to be advancing beyond the warrant of well known facts to regard malaria as an ultimate product in the series of changes going on in the soil—using the word *ultimate* as classifying it with carbonic acid and ammonia, and indicating its competency to take part, like them, in the elaboration of new vegetable tissue. Before this can be admitted as fact we must know much more of the chemistry of soils and the physiology of vegetable life. But, in the meantime, it serves as a convenient platform on which to arrange the apparent vagaries of malaria, enabling us to refer the question of moist soils to a single principle instead of to an aggregation of observed facts.

By viewing malaria as an element in the nutrition of plant-life, exhaled from the soil and absorbed by the myriad pores (stomata) which leaves present, mostly on their under surface, we have an explanation of the luxuriant vegetation which usually indicates its habitat. During the

day, under the stimulus of light and heat, vegetable nutrition is active, carbon is fixed, oxygen thrown off, and malaria absorbed to act its part in the organism. Hence the comparative freedom from malarial poisoning conferred by sunlight. During the night, on the contrary, the plant sleeps, its nutritive functions are at a standstill, and the unabsorbed malaria envelops the foliage in a rich vapor until the morning sun rouses up the organism to profit by it.

On the same principle is explained the prevalence of disease during hot and dry summers after rainy springs, the leaves becoming devitalized, more or less desiccated, stomata shut, and absorption interfered with. So also the pandemics which have always coincided with hot years following on unusually wet seasons, floods, and inundations.

Coasts liable to overflow from the sea are found to be pernicious from the destruction of the fresh-water plants which would otherwise have flourished and rendered them less unhealthy.

River-bottoms and deltas have fresh soil thrown up, by inundation, to ferment in the sun, without a sufficiency of growing foliage to assimilate the emanations.

Hence, also, barren sands with underlying moisture from impermeability of subjacent strata may be as pernicious, or more so, than a rankly growing site.

In temperate climates and in mountain valleys an unusual summer heat may cause such increase in the development of malaria that the indigenous genera are insufficient for its consumption. Thus, we have occasional visitations beyond the usual limits of malarial disease—for the limit is not marked by latitude or altitude, but by a due proportion between decomposition and living vegetation.

Thus, also, can we perceive the bearing of tillage in first developing, and after a time destroying the malarial poison. Cultivation requires in the first instance the destruction of the indigenous flora, which is accompanied by diffusion of the unabsorbed emanations; but, in its perfection, it implies drainage to the extent that heat and moisture will be present only in the degree necessary to produce enough of the aliment for the growing crop. Yet, even where cultivation is well advanced, the harvesting period is liable to be one of disease; and in the best adjusted fields the popular voice has attached a baneful influence to exposure to the "night air."

Breaking fresh ground is dangerous in another connection, which will be discussed hereafter. (See page 152.)

We can thus appreciate the maxims laid down by writers on military hygiene: Avoid the neighborhood of marshes, river-bottoms, overflowed lands, deep alluvium, lands subject to occasional salt-water inundation, and sands, however barren the surface, if there be subjacent water. Grassy surfaces are usually accepted as good camping-grounds. The elimination is small during the night, lies low, and is completely absorbed in the early morning. Were the emanation greater than is sufficient for the grass, other and more luxuriant plants would be growing on the soil. Shrubby

plants are denounced as indicating dangerous ground, for the larger surface greenery indicates increased evolution, which has to rise higher before reaching the absorbing surface. And moreover, camp cannot be established without cutting away many of the shrubs, thus diffusing emanations which they would have assimilated.

On this principle also we can perceive the utility of the belt of trees in protecting from malarious influences—the willows and cottonwoods of our western streams, and the usefulness of such *rapid growers* as the eucalyptus globulus, the thistle, and the sunflower.

Moisture in the soil in its larger aspect depends on the annual rainfall of the section of the country, but, as restricted to the local question of camp-sites, it is determined by configuration of surface, and the greater or lesser permeability of the superficial layers and subjacent rocks. Rain falling on an impermeable surface must run from it into the main water-courses, or lie stagnant, according to the surface configuration. On the other hand, if the soil is porous, more or less water will sink until it reaches the surface of an unabsorbing layer, where it will run off to lower levels, or lie stagnant, according to the configuration of *its* surface. Sufficient inclination to carry off surface water is therefore the first thing to be looked for—the more so as in general the incline of underlying rocks is indicated by that of their superficial covering.

From what has been said it may be inferred that, in directing attention to the soil itself, porosity should be sought, with the bed-rock at sufficient depth to prevent the water upheld by it from influencing the surface layers by capillarity of substance.

The retentive surfaces are clay soils, marls, and humus; the porous, gravel and sands. The retentive strata are clays and the harder rocks; the porous, sandstone and chalk.

Hence the coldness of clayey soils—the probable malaria of the humus—the objection to plains, especially if argillaceous or in moist climates—the salubrity of our western gravelly levels with their dry climate and unfathomable bed-rock. Hence, also, the objection to rolling ground, unless the hollows contain the radicles of a stream with a good outfall—the salubrity of sands where the bed-rock is deep, and their insalubrity where they border watercourses or overlie them, as happens in the sinks of some of our western streams.

But dryness of soil is never determined by the application of instances to the case in question. Its desiderata are a good surface drainage, a porous soil, and a deep bed-rock. These can usually be discovered by a general survey of the ground; but if doubt exists concerning the last, a few men with pickaxes and spades can speedily settle it.

There are other points which enter into the consideration of camp-sites. Advantage in cold climates must be taken of hills and woods as protection against wintry winds; in hot climates, of woods for shade, if not so dense as to interfere with ventilation. Prevailing winds must be observed, in order that we may place the camp to windward of suspicious swamps and rich alluvial grounds. In the mountain districts of the southern territories

the nightly breeze from hill to plain must be remembered in its bearing on the healthfulness of sites. Cañons are hot in the day, oppressive at night by radiation from heated rocks, and liable to inundation from rain-clouds on the mountains. The reflected glare from sand and rocks is often distressing to the men, and protection should be sought from it. A dusty site combined with glare is hurtful to the eyes, and, what is worse, it renders the best disciplined troops careless of their personal police and weakens the hygienic government. Old camp-grounds should be avoided, not alone on account of contamination of soil and danger of infection from previous occupants, but also by reason of the filthy condition in which such sites are usually left. There are many places on travelled roads in the territories where the vicinity of the only water has been so frequently camped on by passing troops and emigrants, that the discomfort, to say the least, of camping on an old camp-ground, can be fully appreciated.

The influence of a dry site and neighborhood for camps, as bearing on the health of their occupants, can scarcely be expressed in too strong language. It is illustrated at every turn in the service of the medical officers of our army, if illustration were wanted of what the history of every army furnishes a record. A Virginian river gave its name to the fever which the Army of the Potomac contracted on its banks.

During our war, dry camps, even on exposed sites, turned out robust and high-spirited men, while in the hollows the troops seemed to be weighted down by the mud which adhered to them, all desire to look smart and soldierly having vanished long before the dampness or malaria sent them first to surgeon's call, and then to the general hospitals in the rear.

Since the war, camps have been established in the West on favorable sites, and our medical officers have seen their garrisons in perfect health until scouting columns have returned with constantly recurring intermittents, contracted in the damp and malarious camps imposed on them by the military necessity of following the trail of hostile Indians.

Perhaps even a more common experience has been that of combating disease in camps which should never have been established. One of the most noteworthy cases of the kind was brought officially to the notice of the writer in 1868, by an order to proceed to Camp Grant, Arizona—a site selected two years before by California volunteers—and report on the causes of its insalubrity. During that year there had been 1,735 cases of malarial disease taken on sick-report in a strength of 215 men,[1] or 8,070 cases per thousand of mean strength. The post was found to be established on a knoll which projected into a river-valley. In front, the valley, three or four miles wide, stretched away in the distance, bounded on either side by high lands and dotted with swamps and morasses. In rear was a somewhat similar view. On the right, the stream—San Pedro River—swept past, usually well confined by its banks, but overflowing at certain seasons. On the left, a tributary—the Aravipa—emerged from a

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[1] Circular No. 4: Barracks and Hospitals, Surgeon-General's Office, Washington, D. C., 1870, p. 446.

rocky cañon and became lost in crossing the San Pedro bottom, except during the rainy season, when, swollen to an impassable torrent and spreading over half a mile of shallow front, it effected a junction with the main stream at the base of the camp-site. No more unhealthy locality could well be found among the many malarious valleys of Arizona. The site was dry and well drained, but its neighborhood condemned it. It is to be presumed no medical officer was consulted in the establishment of this post. Although recommended to be abandoned in 1868, it was not until 1873 that the garrison was moved to a new and healthier location.

Much has been done in this country, since the Report on Barracks and Hospitals was published in 1870, to improve the sanitary condition of the troops; but investigation would seem to indicate the decreasing sick-rate as mainly owing to the abandonment of such sites. In fact, no better argument for care in the selection of site could be brought forward than the ratio of sick per thousand of strength as given by the Surgeon-General in his Annual Reports, although it must be remembered that the record involves attention to other hygienic considerations:

Year	1867:	Cases	per thousand	2,716
"	1868:	"	"	2,628
"	1869:	"	"	2,320
"	1870:	"	"	1,855
"	1871:	"	"	1,863
"	1872:	"	"	1,671
"	1873:	"	"	1,666
"	1874:	"	"	1,514
"	1875:	"	"	1,420
"	1876:	"	"	1,499
"	1877:	"	"	1,482
"	1878:	"	"	1,270

In 1873–'74, the last year of which the records have been published,[1] the most unhealthy of the occupied stations in our service were the following:

Little Rock, Ark.,	giving	1,809	of malarial	cases	per 1,000	strength.
Fort Foote, Md.,[2]	"	1,738	"	"	"	"
Baton Rouge, La.,	"	1,468	"	"	"	"
Fort Gibson, Ch. Na.,	"	1,119	"	"	"	"
Fort Wadsworth, N.Y.H.,	"	915	"	"	"	"

At Little Rock the site is elevated and inclined, with sandstone underlying the light and porous superficial stratum; but the alluvial lands of the Arkansas River furnish the *materies morbi*.

[1] In Circular No. 8, S.-G. O., Washington, D. C., 1875.

[2] While this article was being penned, the garrison was withdrawn from Fort Foote, Md.—an illustration of the gradual weeding out of malarial diseases from our army by abandoning the dangerous sites.

Fort Foote is on a bluff, one hundred feet above the Potomac level, but a marsh four hundred yards wide on the reservation in rear of the post occasions the sick-rate. So, at Baton Rouge, the fault lies with a bayou emptying into the Mississippi two hundred yards above the site.

Fort Gibson owes its fevers to the annual flooding of the Grand River bottom-lands, the post occupying a dry and well-drained site. While, on the other hand, at Wadsworth the site itself is in fault. The reservation consists of irregular ground, the hollows of which being without outlet, form marshes or stagnant pools.

SECTION III.

ON COMPANY AREAS AND QUARTERS.

In examining the internal construction of camps little attention need be paid to the area and housing of officers, as, if overcrowding exist among them, it must be present to a greater extent among their men. The interest centres in the company areas and the arrangements and character of the habitations of the enlisted men.

The company area is the ground covered by the street and the company quarters, without including any of the unoccupied spaces between the latter and the sinks in front, the kitchens in rear, and the adjacent regiments on the right and left. This gives each of fifty-two men belonging to the company—for two are usually on duty at the kitchens—from 7.5 in the condensed to 11.3 square yards in the full-fronted camp, a space somewhat greater than has been recorded as the British allowance.

But, while this area varies with variations in the width of streets, the ground available for the erection of tents or shelters remains the same. In the plan given in Fig. I., which is modelled on the best laid-out camps of our service, it is set down at six yards front per company, with a depth of thirty-nine yards. The sufficiency of this space depends on the manner of its occupation. If the men lie down wrapped in their blankets, as in bivouac, each on the four and a half yards which the area permits him, there is ample space for free circulation of air. But if they are grouped in squads, and covered with a bell-tent as with a bell-glass, a most unhealthy condition may exist within, while without there may be space enough for thorough ventilation.

Thus, crowding in an army practically depends on the system of aggregating the men into squads, and on the character of the shelter which the squad is required to inhabit. The larger the squad and the smaller the superficies allowed it under shelter, the greater the danger of the manifestation of crowd-poisoning ; the smaller the squad and the larger the area, the less danger.

Yet, in tenting their armies, governments seem to have overlooked this, in these times, hygienic axiom. Tents are furnished to hold from fifteen to twenty-five or more men, in which the occupants, closely covering the enclosed area, lie shoulder to shoulder during the night, breathing and rebreathing the deoxygenated air and the humid and morbific emanations from each other's lungs and skin. What matter, in such case, whether the tent be separated from its neighbors by one diameter, or by a diameter and a half, as recommended by the English Sanitary Commissioners?[1] The evil is within, and not without. No matter how thorough the ventilation of the streets and intervals of camp, there must be disease within its lines on account of this local overcrowding; nor will the best system of tent-ventilation prove a safeguard while the men are so closely packed. Disease is proportioned to density. What has been proved of the square mile under the canopy of heaven must surely hold good of the square foot under canvas.

The material of which tents are made in our service is cotton duck. Linen tents were issued to a small extent during the war, but did not give satisfaction; the texture, in rainy weather, instead of shedding water like the cotton, became saturated and leaky.

The regulation tents at present furnished by the Quartermaster's Department are the hospital, officers' wall, and common tents. Shelter-tents, which are issued to troops in the field, are not regarded as tent-allowance, but as means to enable officers and men to bivouac while on active campaign, or on the march with deficient transportation.

The hospital-tent is a rectangular wall-tent, with a fly or extra roof. It is 14 feet long, 15 wide, 11 to the ridge, the wall being 4.5 feet high. Such a tent, the Regulations say, "will accommodate 8 to 10 persons comfortably." In practice, however, during our civil war, the lesser number was seldom exceeded, or indeed reached, except during battle emergencies; in fact, medical officers were inclined to look upon six as the proper number of patients for this tent, to each of whom it affords 35 square feet and 233 feet of air-space. Around the lower edge of the wall is a strip of canvas (sod-cloth), which projects inward, lying on the soil, and prevents air from blowing in between the ground and the wall-edge. The entrance is a perpendicular cut in the centre of its front, which admits of each half being thrown back to expose the interior. When closed it is guarded by a double lapel, which can be securely tied by strong tapes. The rear wall is cut and lapelled in like manner, so that two tents can be joined and thrown into one ward, with a continuous covering or roof. The wall can be looped up in pleasant weather for ventilation. Of late years it has seldom been put to use, as scouting parties in the Indian country travel with as little baggage as possible; wounded and sick are sent to the nearest post for treatment. But in 1861–'65 many handsome tent-hospitals were seen in the field, especially during winter quarters. Canvas hospitals of similar construction have been used since then with satisfactory

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[1] Sanitary Report on Barracks and Hospitals p. 169, London, 1861.

results, in connection with the Boston City Hospital,[1] and by the American Ambulance during the siege of Paris.[2]

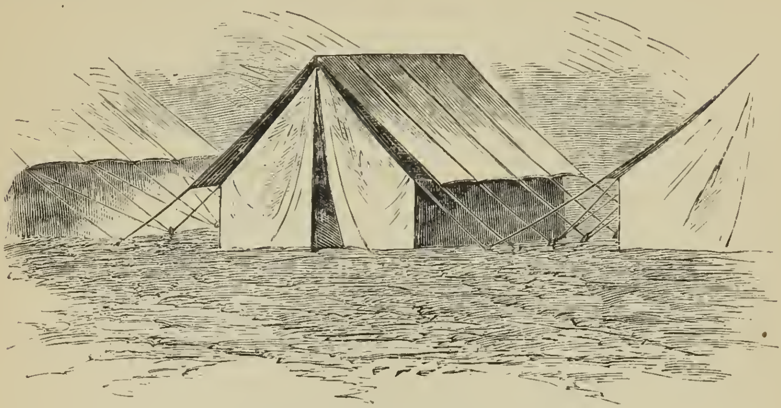

FIG. 3.—Officers' wall-tent.

The officers' wall-tent, Fig. 3, is 9 feet square, with a height to the ridge of 8 feet 4 inches, 3 feet 4 inches of which form the wall; it is furnished with a fly. One is allowed to each captain, and one to the two subaltern officers of each company. To ventilate it, the sides must be raised and the roof cut to permit efflux of air between it and the fly.

The common tent, known also as the wedge- or A-tent, Fig. 4, has a spread of 8 feet 4 inches at the base, and a height and length of 6 feet

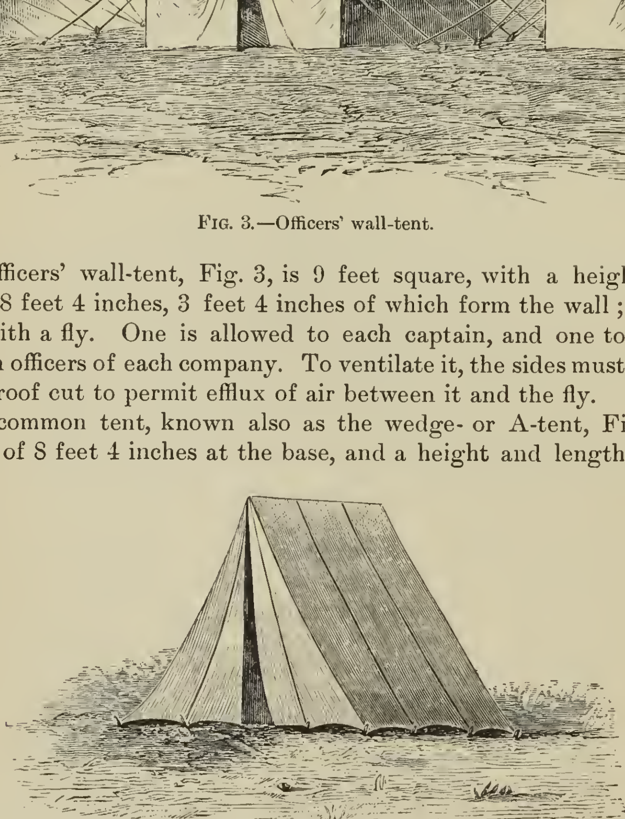

FIG. 4.—The common tent of the United States service, known also as the A- or wedge-shaped tent.

10 inches. It is opened and shut in front, as the hospital-tent, and has a sod-cloth to prevent entrance of air below. It has no provision for ventilation, and as there is no fly, the roof cannot be cut without exposing the interior to the weather. When rendered impervious in wet weather by

[1] Dr. Cowles in Boston Med. and Surg. Journal, July 2, 1874.

[2] Sanitary Associations during the Franco-German War, 1870–'71, Vol. I. The American Ambulance, Thos. W. Evans, London, 1873.

swelling of the fibre and closure of the meshes, the only entrance or exit for air is between the closed lapels of the doorway.

This tent is intended for four mounted men or six footmen. But, as it only encloses a superficies of 57 feet, it is to be presumed that some edgewise packing must be effected by the six footmen, to afford them surface repose while enjoying their 21.7, or rather their 18.7 cubic feet each. Practically it seems a refinement in air-space calculations to make a deduction of three feet per man for body bulk, but in such a case as this the point merits remembrance. A letter from the Quartermaster-General's Office to the writer, dated October 2, 1878, states that "the records of this office do not show by whom the allowance for common tents was fixed."

The reduction of the squad from higher numbers to 4 and 6 is a step in the right direction, but its value is lost by the impaction of the men. However, this is a matter which is faulty only on paper, as practically the tents are seldom used. Each company draws its allowance and places the tents in the barrack store-room, where they are preserved with more or less care until the command is ordered on field service, when shelter-tents are drawn and the others turned over to the post or depôt quartermaster.

Were this tent ventilated by a couple of holes near the ridge, guarded by flaps which could be looped up or let down at pleasure, and furnished at the rate of one to every two or three men, it would be useful in the summer exercises of volunteer militia, as it affords a better protection than the shelter-tent, and forms a more showy camp.

Before, and occasionally during the civil war, the Sibley tent was used by our troops. This was a conical tent, 18 feet in diameter at the base and 13 feet high, supported by a central pole. The apex of the cone was cut off, forming a circular aperture. This was bounded by an iron ring and slung from the upper end of the pole which projected through it. The pole ended below in a tripod which permitted the tent, by a simple movement of the legs, to be tightened up or relaxed, according as the state of the weather affected the canvas. Ventilation was through the circular opening, which, during rains, was covered by a cowl. This tent was intended for 17 mounted men or 20 footmen; to each of the latter it gave 12.7 feet of surface and 55 feet of air-space.

The conical tent of the French army is somewhat similar; but, instead of a cowl, the aperture at the apex has a wooden cap for cover, which can be raised or lowered by corresponding movements of the pole. It is, according to Morache, 6 metres (19.7 feet) in diameter at the base, 3 metres (9.8 feet) high, and has a capacity of 30 cubic metres (1,059 cubic feet), giving 19 square and 66 cubic feet per man to each of its 16 occupants.

The regulation infantry tent of the German army is conical also, but has a wall nearly two feet high at the base, which raises the cone and gives greater freedom of movement on the area.

The English bell-tent is similar to the last. It is 14 feet in diameter at the base and 10 feet high, giving 12.8 square and 42.8 cubic feet to each of 12 men; but, according to Parkes, 16 and 18 men have been crowded

into it. Ventilation is attempted by a few holes near the apex, but they are of little service.

The Indian marquee is a two-poled tent with ridge and fly. It is 21 feet long, 15 wide, and 10 feet 3 inches high, accommodating 20 cavalrymen or 25 infantry. To the latter it furnishes 85 cubic feet per man.

Enough has been said concerning the character, measurement, and occupation of army-tents to show how valueless is the discussion of square yards per man which the company areas will furnish, while the men are deprived of the so many square yards which they *might* have, by being cooped up under canvas on so many square feet.

Small tents diminish the risks of crowding by scattering the men more equally over the company area. Our common A-tent gives 19 square feet to each of three men; the conical French tent is a little more liberal—20.3 feet to each of fifteen. Whether there would be more or less danger of crowd-poisoning among fifteen men in the French tent, or among the same number in five A-tents pitched at proper intervals over the company area, especially if the same effort was made to ventilate the latter as is manifest in the former, is a question which no medical man would hesitate in answering. Then why the large tents? Because the men are more under the eye of authority when grouped in large squads? Increase the number of officers, if need be, but separate the men. Or because large tents are more economical of canvas and there is less weight per man to be transported? But this is poor economy. If there is need of an army at all, it is needful to preserve every soldier at his maximum development of physique and morale.

The question of transportation, however, limits the usefulness of the best of tents. In active operations the smaller the wagon-train the more efficient the army. Weeks will pass in war-times without a possibility of having the trains near the line of battle, except in small detachments for the issue of rations and ammunition. And even on ordinary route marches, with unlimited transportation, the wagons are a drag upon the men, requiring hard labor for the repair of roads, and oftentimes reaching camp so late as to afford the command little opportunity for securing comfort in their tents during the night. There is nothing on a march so dispiriting to men as having to wait in wet weather for the arrival of their trains.

The usefulness of tents is thus narrowed down to camps of more or less permanence; to camps of instruction in field exercises and discipline in times of peace, and during war to the formation of depôts for recruits, camps of organization, siege-camps, and winter quarters in a country unprovided with materials for housing the men. But in all these cases there is no military necessity for crowding the troops into the customary large tents.

In view of the insalubrity of tent-life, the first Napoleon required his armies to bivouac, preferring rather to risk climatic exposures than the dangers of tent-occupation.

In dry and temperate climates, with small diurnal ranges of temperature, men may bivouac without danger. Where the nights are hot as well

as the days, and other circumstances favorable, they may bivouac with advantage. Inhabitants of warm climates often sleep on the roofs and verandas of their houses. But in rainy weather, in cold climates, or in warm climates with clear skies and much nocturnal radiation, shelters are imperative. Under such conditions, only on the eve of battle must the bivouac be permitted, when it is to be accepted as one of the hazards of war.

During the years 1866 and '67, while on duty in Arizona, the writer spent the greater part of each summer and autumn in bivouac. The commands ranged from 50 to 150 men. At no time was their strength in any way impaired by exposure. The men did not burden themselves with their shelter-tents, finding them unnecessary during the warm nights, and a less effectual protection against the rays of the sun than could be extemporized out of brush-wood and blankets, if the camp failed to provide a clump of cottonwood or sycamore. Later in the season, when dews began to fall, the use of the tent was resumed.

The modern shelter-tent is the invention of the French army in Algeria. Each soldier was furnished with a camp bed-sac, which had an opening at one end, into which he first packed his hay or straw, and then insinuated himself ; but protection from sun during the day, and dews at night, being more needful than the bed-sacs, the men slit them open, fastened two together, and pitched them as a ridge-roofed tent open at the ends. The idea was approved, and pieces of canvas, with buttons and corresponding button-holes, were issued, with uprights to support, and guy-ropes or stays to stretch the ridge and ensure stability.

Each piece of the regulation French tent, as given by Morache, is 1.70 by 1.60 metres ($5\frac{1}{2} \times 5\frac{1}{4}$ feet), and the uprights 1.20 metres (about 40 inches).

On its introduction into our service during the civil war, the shelter-tent immediately became popular with the troops—in part, no doubt, to the comparative privacy which it gave to individuals by breaking up the large tent-squad—a point of no small importance among regiments formed of citizen volunteers. But its value as a shelter was also fully appreciated, for regular soldiers, accustomed in barracks to a common dormitory, were, and are during our current Indian troubles, as well pleased with their piece of shelter-tent as were the volunteers.

Experience in its use showed its capabilities not only as a temporary shelter when placed upon the ground, but as a more permanent abode in summer camps when erected over brush-wood, reed, or stockaded walls, or in winter over the more solid walls of a rude log-hut. In fact, the veteran soldier came to regard it as a home, and to have a sense of repose and settledness as soon as it was pitched. It gave him a lien on a certain piece of ground which he could not otherwise have possessed. This feeling alone, in connection with the shelter afforded, must have been powerful as a preventive of disease. But our indebtedness to the shelter-tent does not end here. It scattered the men on the company area, and permitted them to breathe a purer air. Thus were they relieved

from the malaise and debilities induced by deficient aëration of the tissues and imperfect elimination of worn-out material—evils which, while serious enough in themselves, are prone to culminate in a condition of system favorable to the propagation of epidemic disease on the introduction of its specific germ.

FIG. 5.—The shelter-tent.

The United States shelter-tent, Fig. 5, is made of cotton-duck, 33½ inches wide, and weighing 8 ounces to the linear yard. Each piece is 5 feet 6 inches long measured along the foot or top, and 5 feet 5 inches wide measured along the seam. It has nine [1] galvanized or zinc buttons in a line parallel to, and four inches from the upper edge, placed at intervals of eight inches from centre to centre, the extreme buttons being one inch from the side edges or ends. It has also seven buttons parallel to, and four inches from each side edge, with eight-inch intervals between, and the lower button of the row three inches from the lower edge. It is furnished with button-holes, twenty-three in number, along the upper and side edges, at half an inch distance from the edge, and corresponding in position to the buttons on any other piece. The lower edge is provided with three loops, one at each corner, and one at the foot of the seam, by which the edge may be pegged to the ground. The pole and rope-holes are so placed as to correspond when any two pieces are joined together. Pegs and uprights are also issued as part of the tent, but the troops never carry them, relying on the camp-ground or its neighborhood to furnish them. Each piece weighs 2 pounds 6 ounces.

As usually carried by the infantry soldier, the piece of tent is rolled with the blanket into a long cylinder, which is slung from the shoulder to the opposite hip, where the ends are tied together by the guy-rope.

The two pieces when joined form a sheet 5 feet 6 inches long by 10 feet 6 inches wide, four inches being lost from the width by the overlap in buttoning. When pitched on uprights varying from 45 to 50 inches, they give a spread at the base of 6.33 to 7.33 feet, providing a covered area of 17 to 20 feet for each of the two men.

The buttons and button-holes along the side edges admit of the junction of two or more tents into one, to contain as many men as have contributed pieces to its formation; but this arrangement is not favored by our troops.

[1] The figure shows the general appearance of the tent, and the position of the rows of buttons, but does not agree with the text as to the number in each row.

They prefer to "bunk" in pairs, unless in driving rains and strong winds, when there are no means of improvising a protection for the weather-end of the tent, in which case a temporary consolidation of three men to a tent may be instituted, the third man closing up the exposed end by means of his allowance of canvas.

The fault of the shelter-tent as issued is, that it is not long enough for the average American soldier.

In the plan of the infantry camp given in Section I., the width allowed to the double column of tents is 6 yards, the depth 39 yards—an area per tent of 9 feet square; but as the area of each tent is only $5\frac{1}{2} \times 6$ or 7 feet, there are left for ventilation and trenching an interval of 2 to 3 feet between the ranks, and a passage-way 7 feet wide between the two files or columns. Practically, the passage is often reduced to 3 feet by the projection of guy-ropes and pegs, and the closing in of the end of each tent with a brush-wood or other improvised wall; but this is wide enough for ventilation and sunlight and the operations of police parties.

If the occupation of the camp is to last for more than one night, and especially if the site or weather be damp, the men build a raised platform or bedstead of poles and forked uprights, $1\frac{1}{2}$ or 2 feet high. On this their hay, straw, grass, or whatever forms their mattress is spread, and the shelter-tent roofs it over.

Any further stay on the same ground is marked by improvement in the condition and appearance of the shelters, the character of which depends on the available material and the influences from which protection is sought.

Reliance can generally be placed on the ingenuity of a body of men to make the most of the materials at command; but their efforts must be held in check by intelligent supervision. In seeking shelter from that which assails the senses, they are liable to expose themselves to more subtile and dangerous influences, which are unfelt and unknown to them. It is to be regretted, in this connection, that the attention of officers is not drawn formally to the extemporized methods of shelter which experience has shown to be useful. At West Point the cadet is taught nothing concerning the proper mode of hutting troops, and he enters on field service not to superintend the men in such labors, but to be taught by them. He may thus learn to recognize as custom of the service many violations of hygienic laws; and such customs are notoriously difficult to uproot.

In summer camps, or those of tropical countries, the danger is slight that the labors of the men will lead to harm. They seek the air and such protection from the sun's heat and glare, and occasional wind and rainstorms, as is consistent with a free ventilation. Camp Lowell, in Southern Arizona, consisted of shelter-canvas roofing over walls of leafy willow-work, with a huge canopy of brushwood erected high above the tents to afford a better shade. This camp was occupied from 1863 to 1873, and there was no more healthy command in that region of country. During some part of the time A-tents were used, but with only two or three men in each.

But in winter camps, or those of cold climates, the attempt to preserve a certain degree of warmth in the interior of the shelter is virtually an effort at the suppression of ventilation. Much credit is due to the troops in our Army of the Potomac for the efficient and workmanlike manner in which they hutted themselves during the severe Virginian winters. Scarcely a hut was free from faults, but the men were not responsible. The supervising intelligence was absent, and responsible by its absence for crowding from inadequate passages between company files and individual huts, for dug-outs, bank-ups, dampness from inefficient trenching, and the fixation of the canvas roof so that it could not be removed to sun the interior without destroying its usefulness.

But a fault which affected the hutting of the whole army was caused by the inability of the shelter-tent to roof in a sufficient area for winter occupation. Four men usually joined their pieces to complete a hut. The shelter-tent is 5 feet 6 inches long, but when two are united four inches are lost by the overlap. The length of roof was therefore 10 feet 8 inches and its spread 7 feet; but, as the canvas had to be brought down on the outer face of the logs, the interior measurement of the hut was lessened in proportion to the thickness of its walls. Putting these at six inches would give the hut an area in the clear of 9 feet 8 inches by 6 feet, or sufficient for two double bunks with the narrowest of passages between

Fig. 6.—Log hut, roofed over with two shelter-tents, as seen in the winter camps of the Army of the Potomac.

them. But, what with absentees, sick, and on furlough, and the regular details for guard and picket duty, it seldom happened that more than three men had to pass the night in the four-pieced hut. A broad platform was accordingly built in one end as a bedstead for three men, leaving a space at the other of about 3 feet by 6 feet as a living room, on the floor of which the occasional fourth man would spread his poncho and blankets at night.

The doorway opened from the street into this space; a cupboard or shelves were placed in the angle near it, and an open fireplace in the opposite wall. The preservation of the chimney was a source of much labor and constant anxiety to the occupants of the hut, as, although sometimes built of stone, it was more frequently a narrow wooden shaft, lined with layers of clay to prevent its timbers from catching fire. Yet it was deserving of all the attention bestowed on it, as, when in good working order, it gave a cheerful glow to the interior, and at all times established a connection with the external air.

We have found the company tenting-ground to afford 9 feet square per tent—the four-pieced hut has therefore a space 9×18 feet for its site; but, as it only covers 10 feet 8 inches by 7 feet, there exist intervals of seven feet between adjacent huts of the same row, and a passage of four feet between the files or columns. The former space is ample, but the latter insufficient, as the chimneys project into it on either side, converting it into a sinuous pathway. Space should be taken from the width of the street to increase the interval between the files.

With a wall five feet high the hut would have a capacity of 365 feet, or 91 to each of four, and 122 feet to each of three men—more liberal even in its smaller figure than the best of army-tents; yet by no means sufficient for the occupants. A higher wall would have given greater space; but, to them, area, not air-space, was the desideratum. Those who possessed an extra piece of shelter-canvas, or a spare poncho, cut it in two longitudinally, and applying it to the roof, lengthened their hut by two and a half feet. This small increase of area made all the difference between compression and comfort. Such as they were, however, large and small, the huts were looked upon with infinite regard by those whom they sheltered.

The general opinion of writers on army hygiene is in favor of huts for occupation during cold weather. Prof. Parkes [1] says they "are better adapted for winter quarters than tents." According to C. A. Gordon,[2] "It is not considered desirable that large bodies of troops should occupy tents during winter in Europe or America; when, therefore, accommodation for them during that season has to be extemporized, huts ought to be erected for the whole." But these and other writers recommend the hut to hold large squads. The Crimean huts were occupied by from twelve to twenty-four men. The directions given for their erection imply the presence on the camping-ground of specially provided material and labor. But huts built *by* the troops and huts built *for* them are two different things.

It is very well for medical officers to put themselves on record as insisting on such numbers as 40 square and 400 cubic feet [3] of hut per man, with double walls, raised floors, ridge ventilation, and warmed air-supply;

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[1] Manual of Practical Hygiene, London, 1866, p. 301.

[2] Gordon : Army Hygiene, London, 1866, p. 123.

[3] Hammond : Treatise on Hygiene, Phila., 1863, p. 451.

but, practically, they have to do with quite another style of hut. In the sudden settlement of a large army in its winter quarters, the excess of transportation required for an attempt to house it is not always available; and in our recent Indian campaigns deficient army appropriations denied both material and transportation for such temporary purposes. Hence, like the men, the army surgeon must accept the materials which the camp neighborhood affords, and make the best of them.

For the walls the country can generally furnish all that is necessary. Even on our stretches of western sage-brush, where there is a total absence of timber, walls can be raised of adobes or sun-dried bricks. But, to perfect the roof without outside assistance, is often impossible; and without a sound roof walls are valueless. The writer has been on duty with troops who, having built handsome adobe walls, could find nothing but cottonwood timbers on which to lay the flattened mud-roof; and as these timbers, on account of their loose cellular structure, warped exceedingly, curving up at the ends, the roof lost that slight inclination which was necessary to shed the rain, and became converted into a shallow basin, from which percolation into the interior was established.

A quotation from a report of personal experience is in place here:[1] "The great objection found by the troops to quarters of this kind (adobe huts with mud-roofs) is the character of the roof. None are free from leaks. At one post, during a continued rain, such men as could procure shelter-tents pitched them over their bunks, in order to keep themselves dry at least during the hours of their sleep. Tent-flies and wagon-covers were made use of to protect the worst points in the roof; but, notwithstanding all that could be done, the earthen floor of the room became a mud-puddle, and for want of sufficient sunlight and ventilation remained damp for many weeks afterward, while the sick-list was crowded with bronchial attacks and rheumatic affections attributable to the condition of the quarters. Nor was the hospital at this time in better condition. Beds occupied by dysenteric patients almost *in articulo mortis* had to be moved from one position to another, to avoid the muddy water flowing through the leaks in the roof, until at last no dry spot could be found, when they had to be protected by rubber blankets and gutta-percha bed-covers."

Canvas forms the best, because lightest and most portable roofing material, which troops can draw from their base of supplies. The shelter-tent has been shown to be invaluable—in fact, all that is essential on campaigns and marches, and in the summer camps of temperate and warm climates, where the men live in the open air and employ the tent only as a covering to the bedstead. It has been found inadequate, however, to roof in a proper area in winter camps where many hours of the day have to be spent under it as in a living room. Yet, from what has been written, it is patent that for such camps the log-hut with canvas roof is in every respect superior to the regulation tents.

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[1] Special Report on Service in Arizona, in Circular No. 4, Surgeon-General's Office, Washington, 1870, p. 456.

Sheets of canvas or flies of a given size, to cover over a hut built according to a regulation plan and dimensions, would do away with the necessity for a regulation tent allowance, and settle the unsettled question of the best model of an army-tent by abandoning the tent system, as did the great Napoleon. Exception to this must be made in the case of our hospital-tent, but solely because hospital details are insufficient in force to build proper hut-hospitals.

If, in preparing for a winter camp, the supply department issued to every four soldiers a piece of roofing canvas 14×12 feet, and a second piece, somewhat larger, as a fly to cover the roof, the log-hut could have an interior measurement of 13×7 feet, giving room by its length for a double bedstead at each end, and a small moving space between the doorway in the front wall and the fireplace opposite. With the wall raised six feet, which should be its minimum height, the hut would have a capacity of 700 cubic feet, the air of which would be freely renewed by imperfect chinking between the logs, by the chimney draught, and ventilators near the ridge, which could be placed in the roofing canvas, protected as they would be by the outer or fly covering.

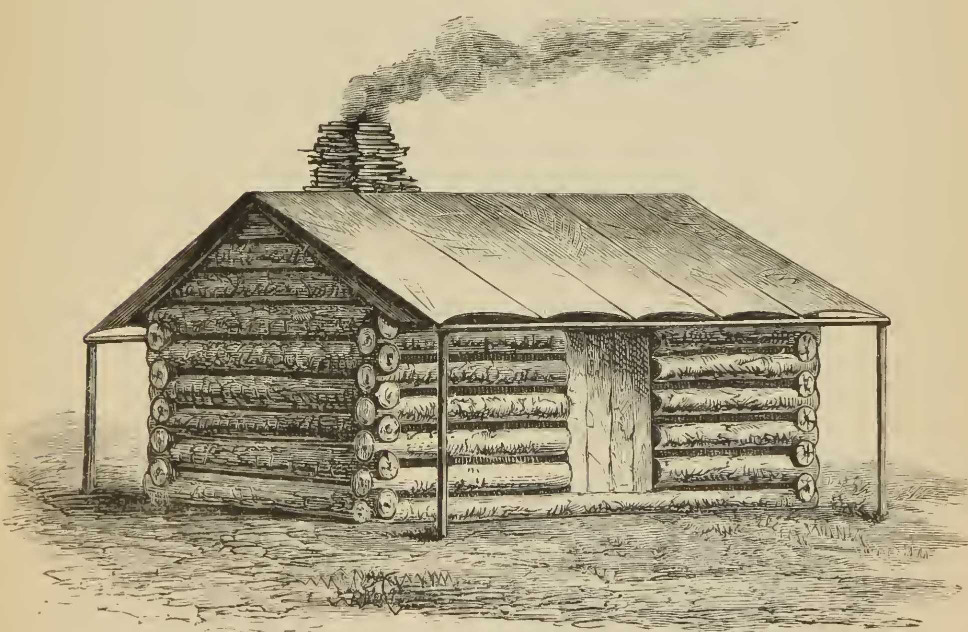

FIG. 7.—Winter hut for four men—the canvas roof protected by a fly, which is fastened to a rail near the eaves.

Theoretical hygiene may object to this allowance of air-space and area in the proposed hut, but the measurements are suggested advisedly, and are based on a knowledge of the military tendency to close up and occupy unoccupied spaces. Give possible bed- and elbow-room in the hut for a

fifth man, and the fifth man will be immediately naturalized in it. The hut will be no longer a hut for four, but for five men.

The tendency to crowding the huts on each other should be counteracted by specification in regulations of the distance to be preserved between them. The minimum interval between those of the same row should be equal to the height of the walls, 6 feet; while the passage between adjacent rows or files should equal the height to the ridge, about 10 feet. If the company front is too small to afford this without undue narrowing of the streets, the camp should be formed in column of divisions (see page 85).

There can be no excuse for diminishing company areas in winter quarters.

The first care in erecting such dwellings should be devoted to freeing the building ground from moisture. Dryness is essential. What has been said generally of the camp-site applies locally to the site of individual huts.

The sides of streets and intervals between companies must be trenched, and transverse cuts made between these, uniting them, and mapping out the sites of the various cabins. If there is surface drainage from higher ground, it must be intercepted and turned aside. If rain fall during the period of preparation and building, the canvas should be pitched over the sites to protect them; but in dry sunny weather they are better exposed.

On a dry soil the huts may be erected from the ground level, the herbage being plucked from the enclosed area, the soil well stamped with sand and gravel, and subsequently concreted. But on damp sites the walls should be raised a foot from the surface, and the hut floored with split or dressed logs.

The canvas roof and fly should be so fastened that they can be unhitched at a moment's notice to sun the interior—the former to the outer facing of the logs, and the latter, in order to free the streets and intervals from pegs and fly-ropes, to a rail placed just below and beyond the eaves.

Lime should be obtained by the supply department, by burning in the vicinity or transportation from the base, to enable the men to chink the logs, concrete their floors and upraise the flues.

The soldier in cold weather is prone to burrow, and special attention must be directed to guard against this tendency. In fact, a protest must be entered against everything which causes dampness of the interior. The earth must not be banked up on the outside of the logs. The floor must not be dug out to bring its level below that of the surrounding ground, nor must a side-hill be dug into to form part of the end or side walls of the intended hut. Many examples of such faults in construction were to be seen in the winter camps of the Army of the Potomac. Oftentimes the hut was converted into a half-sunk cellar by a combination of excavation with the banking-up method. No notably disastrous results followed, probably because most of these excavations were on hill-sides in exposed

situations and peculiarly dry sites. At Cole's Hill, Va., in 1863–'64, the Massachusetts regiments of the Second Division, Second Corps, were in dug-out cabins on the slope of the hill, yet no men in the command were in finer condition.

On the other hand, in the experience of armies, severe epidemics have so often coincided with the occupation of such quarters, that among army surgeons there is no hesitancy in condemning them. Irrespective of disease due solely to humidity, the risk of miasma in turning up the ground is very great. The heat of the hut, when well warmed by its open fireplace may recommence changes in the organic matter of the humid soil, which the external winter temperature had checked. A localized and artificial generation and evolution of noxious miasm may be set up, prostrating the occupants with intermittents and dysentery. Especially are these results to be feared when the winters are mild. It should be set down as a fixed principle in hutting that the soil be as little disturbed as possible.

The experience of our service shows that, with care in the preparation of the site and in the exclusion of injudicious disturbance of its soil, armies may campaign and summer under shelter-tents, and winter in such cabins as have been described, with far less risk of the development of diseases due to local overcrowding, or the spread of those propagated by specific causes, than in the regulation army-tents or the large squad-huts of our writers on military hygiene.

SECTION IV.

ON THE HYGIENIC GOVERNMENT OF CAMPS.

In investigating the conditions affecting the hygiene of camps the police system is at this point offered as the subject for discussion. The site selected and habitations built, the question in natural sequence is the hygienic government.

Order and cleanliness, so far as they relate to the health and well-being of the inhabitants, are embraced generically by the police system. In civil communities, where the maintenance of *order* requires special officers, the generic phrase has a popular application to the system and officers which effect it. But in the army, where discipline takes the place of this special force, the application of the phrase is practically restricted to the particular of *cleanliness*. A police party is a cleaning-up detail. The soldier has even specialized the word to personal matters, for his object in going to the river or bath-room with towel, soap, and change of underclothing, is usually to have a "general police."

The police system, as thus understood, is of greater importance to the sanitarian than either site or dwellings, in this, that while in the latter

one decision is final, in the former the supervising intelligence has to be continually on the outlook to guard against danger. Its vigilance must be unrelaxing and must increase with the continuance of the occupation. Indeed, when other circumstances are favorable, the length of time during which a camp can be occupied depends on the efficiency of its police. Camp-sites have been recommended to be changed at least every eight days, if circumstances permit;[1] but with proper government the ground can be held for a much longer period.

Dr. Letterman, U.S.A., in a communication to the commanding general, much of which was published in orders to the Army of the Potomac while in camp at Harrison's Landing, in 1862, recommended that tents be struck once a week and pitched upon new ground. This was judicious under the circumstances The camp was a summer resting-place after a most arduous campaign in which the men had become broken down by overwork, climatic and malarial exposures, and an insufficient dietary. Every measure had to be adopted which would tend to the restoration of health and efficiency; and, as the troops, although veterans by virtue of their seven days' fight, were by no means adepts in camp conservancy, the precaution was needful.

The commanding officer is responsible for the condition of his camp; but, as the regiment is the unit of the army, regimental commanders are the officers on whose ability so much is dependent. Company officers oversee the police of their company quarters and the personal cleanliness of their men. To effect the general police of camp, captains of companies are detailed in rotation as superintendent of police, under the military title of *officer of the day*. This officer has command of all the guards and prisoners, and is responsible to his superior for the order and cleanliness of the camp. He makes use of the prisoners in policing the grounds, and, if they are insufficient for the work, fatigue details are granted him. As every day brings a fresh officer to superintend, the system is satisfactory with efficient officers.

But with inexperienced troops and careless or incapable government a good natural site can speedily be rendered unhealthy by contamination of the soil with organic impurities. Change of camp might thus become needful every eight days, especially in warm and moist climates or seasons. In fact, if police parties fail to remove the dangerous material from camp, camp must be removed from the dangerous material.

Yet, when the constant traffic on the company area is remembered, and the steady accumulation of refuse engendered by it, soil-contamination is seen to be but a question of time, in spite of the most effective police. Hence, the occupation of winter quarters should not be prolonged after the advent of warm weather.

Inspections are frequently made by the military authorities—so frequently that the mind of the soldier may be said to have connected policing with inspections to the exclusion of the end for which both were in-

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[1] C. A. Gordon: Army Hygiene, p. 123, London, 1866.

stituted. The effort is made to show clean on the surface, no matter how it may be beneath it. For inspection it is sufficient that the dirt be hidden from the inspecting officer, the how and where being unimportant. In a squad-room the writer has found that the men, after deluging the floor with water and going over it with scrubbers, were in the habit, instead of mopping up the water and rubbing dry, of opening a knot-hole in the flooring and swabbing the water through it, running on fresh water until it swabbed through clear. The result at inspection was satisfactory, but questionable in a sanitary point of view, after what has been written concerning dampness of site.

There are, or were until recently, permanent camps in the West, which, while scrupulously clean on their parade, their streets, their company quarters and all ground subject to inspection, had around them for a radius of a quarter of a mile a surface strewn with all kinds of refuse—bones, tin cans, abandoned clothing, cattle-manure, etc., while ravines in the neighborhood were magazines of such articles in consequence of individual efforts to save transportation to the officially recognized dumping-grounds. So, in the field, with careful police of the regimental camp, the intervals between regiments and the thickets and ravines around were liable to become unauthorized depositories of all kinds of filth, leading to miasmatic developments from soil-pollution, and frequently to taint in the water-supply.

Among the various inspections required by the Revised Regulations of the Army, 1863—still the official reference in military matters, but modified in many respects by orders of later date—inspections of companies every week by company commanders, of regiments every month by regimental commanders, and at intervals by superior authority or its delegate, there was no provision for a purely sanitary inspection. The duties of medical officers were defined, but they related solely to the care of the sick and to hospital management. It is true that, as staff officer of the command, the surgeon accompanied the regimental commander on his inspection, to give professional opinion on matters referred to him; but his opinion might not be required, or, if required, might not be acted on. Active interference on the part of the medical officer was not countenanced. Nevertheless, the esteem in which professional knowledge is held by intelligent military men often led to a due appreciation of volunteered advice, although it not unfrequently happened that suggestions by the regimental medical officer on such a subject as the police of camp would be construed and resented as an unwarrantable criticism by a subordinate on the methods of his superior, the result of which would be the suppression of the surgeon as an officer of health and the loss to the command of his knowledge of preventive medicine.

Dr. Tripler, U.S.A., in his Report of the Operations of the Medical Department of the Army of the Potomac in the Peninsular Campaign, states[1] that: "To superintend the sanitary condition of the regiment, to

[1] History of the War, Med. Volume, Part 1st, Appendix, p. 45, Washington, 1870.

call upon the commanding officers to abate nuisances, to take measures for the prevention of disease, was, in many instances, considered impertinent and obtrusive, and the suggestions of the medical officer to these ends were too frequently disregarded and ignored."

In 1862 sanitary inspection was instituted. To each corps of the army in the field a medical officer was detailed for this duty. He was required once a month to visit and report on the condition of every regimental camp in the command. Extracts from his reports, calling attention to neglects, were sent by authority to the officers concerned. This did good. But perhaps greater, because more seasonable, good was accomplished by the opportunity afforded the regimental surgeon of sustaining his opinions by those of the inspector, backed as they both were by the official recognition of the medical as a sanitary corps.

After the war the Medical Inspector's Department was disbanded, and medical officers returned to their *ante bellum* status and duties as defined by the Regulations. General J. B. Brown, U.S.A., Medical Director of the Department of the Platte, writing in 1869 concerning delays in the construction and repair of hospitals in the face of the most urgent representations of the medical officers, states that:[1] "After a careful examination of all the correspondence available to me in connection with the posts in this department, I am forced to the conclusion that the personal popularity or influence of the post-surgeon with one or both of the above-named officers (the commanding officer and his quartermaster) has in most instances determined the promptness with which the post hospital has been commenced and finished." Dr. Brown might have gone further and said with truth, that in many cases the action taken by the commanding officer, on the suggestions of the post-surgeon, concerning other matters pertaining to the sanitation of the command, was determined in like manner.

The writer has in remembrance an instance where, scarlet fever having occurred during two successive winters in certain huts occupied by laundresses and their families, the medical officer on duty made repeated and earnest efforts to have the dangerous buildings disinfected before the coming of the third winter. No attention was vouchsafed by the post-commander; and during the following season the medical officer had to minister as physician to the individual cases, two of which proved fatal—of a disease, which, with official recognition as a sanitary officer, he could have prevented.

In 1874, however, an order was published which did away with this unsatisfactory state of things,[2] by elevating the medical officer from the position of attending surgeon to that of sanitary officer, which the higher class of military intellect had long before assigned him. It constituted him a sanitary inspector of the command, instead of a mere book of reference, which the commandant might consult or not, as it pleased him, and

[1] Circular No. 4: Barracks and Hospitals, p. 328, Washington, 1870.

[2] General Order 125, War Department, Adjutant-General's Office, Washington, D. C., November, 17, 1874.

removed the final action on his recommendations to a higher authority than that of his immediate superior.

It is so important in its bearing on the hygiene of the camps of the future, that no excuse is required for quoting as follows :

"An important part of the duty of a medical officer of the army is the supervision of the hygiene of the post or command to which he is attached, and the recommendation of such measures as he may deem neeessary to prevent or diminish disease among the troops.

"For this purpose he shall at least once a month examine and note in the medical history of the post the sanitary condition of the quarters, including all buildings belonging to the post, the character and cooking of the rations, the amount and quality of the water-supply, the drainage, and the clothing and habits of the men, and make a report thereon in writing to the commanding officer, with such recommendations as he may deem proper. If the recommendations be approved and carried out, the medical officer shall note the fact in the medical history of the post. If the action recommended be deemed impracticable or undesirable, the commanding officer shall endorse his objections on the report, and forward it to the department eommander. A copy of such endorsement shall be furnished to the medical officer, who shall record it in the medical history of the post."

Had such an order been in force during the war, to give, not weight, but an official seal to the verbally expressed opinions of regimental medical officers on questions of eamp police and others of sanitary import, there would have been less need for medical inspectors, and less sickness in the army from preventable causes.

The general police details clean up the regimental area, attend to the condition of the sinks, remove kitchen-refuse and stable-manure, repair defective trenching for surface drainage, and keep the pathways passable in snow-falls and rainy weather.

All refuse material is collected into heaps, loaded on a light wagon, and carted away. Nothing should be left as a nidus for further accumulation. Soldiers object to doing other than their own work, so that what has been unintentionally neglected by one police party may be seen and passed over by those which succeed it, until the neglect becomes an evil requiring special direction for its removal. Moreover, it will often happen that a nuisance of slow growth will be overlooked by the officers of a camp, and tolerated, through habit, long after it has assumed what, to the eye of a stranger, would seem to be dangerous characters. Special inspectors have a value in this connection.

Nor should the attention be restricted to the regimental area. The surrounding grounds have to be carefully policed, especially if related in any way to the water-supply. In army camps the police labors of adjoining commands should overlap rather than fail to meet.

The sinks in an aggregation of regimental camps are of necessity in front of the men's and in rear of the officers' quarters; but in detached camps, where there is choice of ground, they should be placed, if not to

leeward, in such position that the prevailing winds shall not carry odors over the company areas. They are usually long trenches about eight feet deep and two feet wide, with the earth which has been dug out piled along one side, whence it can readily be thrown by the police party over the accumulations of the day. On the other side a stout pole is laid horizontally on forked uprights, at a proper height, for the convenience of the men. The whole is surrounded by a thick-set hedge of brushwood, through which admission is given by an oblique or valvular entrance.

Small sinks for each company are better than one or two of large size for the regiment. The men, when attending to nature's call, are thus exposed to a less heterogeneous effluvium, a point of much importance in limiting the spread of miasmatic contagious disease. A comparative privacy is also ensured, which has a hygienic value, inasmuch as some men find difficulty in relieving themselves in the presence of others. Such cases, mostly young soldiers, failing to find the sink unoccupied, will take to the bushes or pass the call unheeded.

When the stay in camp is prolonged beyond a day or two, the horizontal pole should be superseded by box-seats, open behind, so that earth can be thrown in. While in winter quarters, the mouth of the trench should be completely boxed with covered seats, the top or one side being hinged to admit of layering the daily deposits with earth.

When filled within two feet of the surface, each sink should be replaced by a new one, those disused being filled up and banked over with earth to mark their site.

In the event of the presence in camp of such diseases as diarrhœa, dysentery, typhoid fever, cholera, etc., special disinfection of the sinks is indicated.

Much may be done, by care and attention to the condition of the sinks, to promote the comfort and well-being of the men.

No satisfactory provision can be made to prevent soil-contamination from urinary secretion. During the day the sinks are accidental receptacles for a large percentage of such discharges; they may even be specially visited as urinals, if the paths are good. But, in bad weather, their distance leads the men to find some concealed place near the quarters, usually in the intervals between huts. At night all parts of the company area are liable to contamination. The extent to which this takes place can only be appreciated after a quiet snowfall, when a record is left of every discharge. Unless officers are vigilant, certain angles about the huts will soon evolve ammoniacal odors. The plan of placing a night-tub is objectionable, in that it cannot be of use to all without being too near to some.

The medical officer should indicate such places, if any, as may be used in addition to the sinks, and the men be held to a strict observance of camp sanitary orders.

Kitchen-refuse and slops are collected in covered barrels and removed daily. On no account should anything of this kind be committed to the trenches or thrown in heaps before removal. Kitchen-garbage is disgust-

ing at all times, and, in addition to the insalubrity caused by its fermentation in the soil, it is provocative of much discomfort in warm weather, from the myriads of flies which infest its neighborhood. The barrels should be placed on a tray or raised platform for the better protection of their site.

Stable-manure should also be carted to the general dumping-ground, the position of which is selected, both as to distance and direction, with a view to prevent pollution of the air- and water-supply of the camp or its neighbors. All slaughter-house offal should be buried here, as also the carcasses of dead horses, mules, etc.

Without efficient surface drainage there can be no cleanliness in camp. Water in the surface-soil is quickly transformed into mud by the ceaseless traffic. This is not only dangerous to the health of the men and the cleanliness of themselves and their belongings, but wraps up and hides all the organic matters which it is the object of police parties to remove. Dry, porous soils may absorb the rainfall promptly, but the best natural site can be improved by systematic trenching. Every depression in the regimental area liable to retain water should be drained and filled up. The company streets should give firm and dry footing when the men turn out at roll-calls. The pathways or sidewalks along the streets to the sinks, kitchens, officers' quarters, etc., should by trenching, grading, gravelling, or other means, permit of a dry-shod performance of the routine movements of camp-life. The perfection of the work must depend on the permanence of the camp, but the main features of the trenching plan should be worked out at once, leaving improvements to follow as the stay is prolonged. There were camps in the Army of the Potomac, in wooded flats with retentive soil and poor outfall for drainage, where certain regiments kept themselves dry and clean on raised board-walks of split logs laid down in dry weather by the foresight of commanders; while others, their neighbors, were swamped in mud and insalubrity.

Company police is local and relates to the cleanliness of the quarters and kitchens, for which, as well as for the personal habits of the men, the company commander is responsible. This officer is required by Regulations to inspect his command every Sunday morning, but with efficient officers this is a formality, as they are cognizant of everything bearing on the health or comfort of their men at the moment of its occurrence.

The interior of the tents or huts should be scrupulously clean. In the temporary camp the floors should be dry; in the more permanent they should be dry and hard, or, if boarded, a plank should be taken up to expose the condition of the site. The air ought to be free from organic taints, and the bedding from dampness; the underclothing in the knapsack clean, as well as that in use; and the condition of the person should form no unfavorable contrast with that of the kit.

In temporary camps the blankets should be aired daily; and in the more permanent, in addition, the fly and roofing canvas ought to be thrown back to admit sun and air for the dissipation of organic exhalations. Nothing should be permitted to accumulate under the bedsteads.

Dogs are a camp nuisance which ought to be cleaned out. In fact, no organic contamination should be permissible in the small air-space, save that which of necessity arises from the occupancy. A hut in connection with the kitchen should be erected as a dining-room, and the carrying of food to quarters strictly prohibited.

So far the preservation of the habitations in a state of comparative purity can readily be effected; but, as regards cleanliness of clothes and person, without which the other items of company police are deprived of much of their value, several circumstances combine to interfere with its satisfactory attainment. Chief among these are habits of carelessness engendered among the men by lack of facilities while on active campaign, with deficient water-supply in camps, or want of means to use it to advantage. Foul camps from inefficient general police (regimental mismanagement) may render futile all attempts at the preservation of cleanliness by companies or individuals. The conditions of camp are so related and interdependent that neglect of one point is more or less harmful to all.

Too little attention was paid to personal cleanliness in our army when on its war-footing. As a result, numbers of men were disabled on every movement by preventable chafings and ulcerations. Nor was positive disease lacking as a consequence, for the irritation of skin caused by heat, perspiration, the contact with underclothing hardened with moisture, organic elimination and epidermal débris from within, and dust and all manner of uncleanliness from without, led to papillary inflammation, accepted in its milder forms as prickly-heat, but which, in cases aggravated by the nails of the individual and the browsing of the *pediculus corporis*, became erythematous, eczematous, and formed a special disease popularly known as camp eczema or camp itch.

The amount of suffering and loss of rest from various degrees of this condition did much to impair efficiency, irrespective of the loss from men absolutely driven to hospital for relief.

The disgust with which individuals of cleanly habits regarded themselves and their neighbors, when more or less affected in this way, was often productive of low spirits and homesickness. The most careful men would become infected with the pediculus by contiguity, and their feelings would be as much fretted as their integument by the infliction. This may appear to be sentiment, but it had an anti-hygienic tendency, for, as Morache says in speaking of the gayety of the French soldier, "De la mélancolie à la maladie, il n'y a qu'un pas."

Again, to appreciate the evils accruing from unclean underclothing, it must be remembered, that in proportion as the fabric becomes matted with inspissated organic matters its virtue as a non-conductor is impaired, and its wearer exposed to danger from this secondary condition.

Blankets also, which were seldom scoured—never would perhaps be nearer the truth—became deteriorated by permeation with extraneous matters, and by the foulness of their contact rendered cleanliness of the person impossible.

Yet in all cases company officers can do much to improve the personal

police of their men. In summer little is required save inspection to determine condition and orders for its improvement. The men can wash in the open air. But, in winter, shelter and warmth must be provided. Huts should be built as lavatories, convenient to the water-supply, and with safe drainage to carry off the waste water either by surface trenching or through a covered sink. Such lavatories have been erected under the orders of energetic officers, and a hot-water supply extemporized by converting a camp-kettle into a boiler and connecting it by circulation-pipes with barrels from which the hot water could be drawn off by faucet as required.

Not that improvisations of this character are recommended, but as showing what can be and has been done by officers who have had interest in the welfare of their men. The soldier should not be thrown entirely on his own resources. Each lavatory should be well outfitted in winter or other permanent camps, by the Quartermaster's Department. Bathing facilities are not here referred to, but facilities for cleaning the hands, face, and feet at any time, the whole body surface occasionally, and the underclothing and blankets, as may be required to keep them in fit condition for contact with an unsoiled skin.

Bathing is a luxury which cannot be afforded the inhabitants of a large winter camp. In summer, however, no opportunity should be lost of enabling the men to have a plunge in the ocean or stream. The ordinary precautions must be taken to ensure invigoration as a result, and, in addition, it should be borne in mind that malarial poisoning contraindicates the cold bath. The chill to the surface in men liable to intermittent attacks is apt to be followed by a recurrence of the active phenomena of the disease. So well known was this to the troops stationed at such posts as Camp Grant, A. T., referred to in a previous section (page 94), that bathing ceased to be regarded as possible, although the gurgle of the passing waters was constantly sounding an invitation in the warm summer days.

Before concluding this section on hygienic government, a reference is needful to certain camp conditions which predispose to, and exaggerate the mortality of all other diseases. These influence the system through the nervous centres, and are the result occasionally of disaster to the flag, but chiefly of the tedium which not unfrequently attaches to the life of the soldier.

The fatigues of a march, and the excitements of an active campaign, stimulate the nervous energies to a high point. On the inauguration of a permanent camp, the labor necessary to secure shelter and comparative comfort fully occupies mind and body. But after a time, unless a healthy safety-valve be provided for the nervous force which has heretofore been expended in the superintendence of muscular action, and in vital resistance to exposures, the soldier becomes fretted by the tameness of his camp-life. Tobacco is smoked during this period of listlessness and inactivity, nominally to pass the time, but in reality for its sedative influence on the unemployed nervous system, until the circulation becomes poisoned,

and loss of appetite, impaired digestion, and prostration of nerve-power are the results—the last being manifested by languor, tremulousness, palpitations, and obscure cardiac pains. If alcoholic liquors can be obtained, they are much resorted to at these times, and the excesses tell on the nervous system by depressant action. Vicious dealings with the generative function have, in individual cases, furnished the temporary excitement, and produced that subsequent collapse of the vital powers which has figured on the registers as "nostalgia." Gambling is the favorite excitement of many, and prolonged sessions are held in cramped positions and foul atmospheres, implying loss of sleep and disorder of assimilation.

Excitement is craved—something to do to pass the dull hours. Drills and parades are better than nothing, as furnishing occupation and exercise; but they are distasteful to the men, as devoid of excitement and savoring of unnecessary work.

Company commanders should cater to the tendencies of the leading spirits of their command. There are always certain men who can carry the crowd with them, either into foot and base-ball clubs and other outdoor sports, or to minstrel troupes and semi-theatrical entertainments, which afford amusement to all, either as actors or audience. These men should be encouraged as the most valuable for the time-being in the camp. Horse-racing affords an interest to all; and target-practice—not the formal so many rounds per man of duty firing—but competitive shooting by teams from the different regiments. Pedestrianism ought to be cultivated among infantry troops, and prize-matches arranged for favorable days.

In large commands, men can be picked out with special talents as vocalists, prestidigitators, gymnasts, etc., and these should be organized as an army company and encouraged by official recognition and assistance in catering for the amusement of the troops. Everything of this kind would be hailed with enthusiasm.

A camp kept well amused will be a healthy one—free at least from all nostalgic influences—and the object to be gained, as promotive of efficiency, is worthy of special effort. In large commands, an officer should be detailed as Superintendent of Public Amusements, who should be manager of theatrical performances, races, competitive shooting and prize competitions of all sorts. If active and enterprising, he would save many from the sick-list, and tide the command over the tedium of winter quarters with undiminished nerve-force.

SECTION V.

ON THE WATER-SUPPLY OF CAMPS.

A dry site and neighborhood, with wood, water and grass, are the essentials of a salubrious camping-ground, the water being understood to be both plentiful and good.

Quantity of supply has a bearing on health chiefly through its relation to personal cleanliness. It may, however, be so scanty as to require special precautions to prevent it from exercising a direct maleficence.

On the march the water-supply is limited, consisting for each man of what is carried in his canteen. No dependence should be placed on the probability of replenishing it while on the route. Daily experience shows the policy of this suggestion. The guides for its use should therefore be, not the desires of the individual, but the water-level in the canteen, and the length of the day or journey. Ignorance or neglect of this rule is often the cause of much suffering, premature exhaustion, and demoralization among inexperienced troops on a long or hot march.

On arriving in a camp where the water is deficient in quantity, the officer who selects the site places a guard over the supply until the orders of the commandant concerning its distribution have been ascertained.

In many parts of the West water is so scarce that judicious management is required to forward troops over the route. Some camping-stations having only enough for one or two companies; the command, if larger, must pass in detachments. Or, it may happen that the distance between the nearest water-supplied sites is too great to be marched without rest, in which case a dry camp must be formed at some intervening point. The passage of the Gila Bend Desert, 35 or 40 miles from water to water, is usually effected by making a night march of twenty-five miles, when the troops go into camp to rest for a few hours before resuming their journey, and to have coffee issued from a water-supply carried in the wagons.

Railroad facilities are doing away with many of the dry camps and forced marches which our troops had to undertake *en route* to certain stations; but on Indian campaigns the water-supply, from its scarcity, is sometimes such as to cause anxiety for the safety of the command. (See page 159.)

The supply in permanent camps can often be increased by well-digging, or, if the soil is dry and subsoil water low, by building reservoirs for springs or small streams which would otherwise run to waste, or by carrying the water in acequias or surface-trenches from some distant source.

While quantity is an accident which gives concern only in occasional cases, quality is an essential which has to be studied in every case.

In route-camps and the temporary strategic sites of an active campaign little opportunity is afforded for examination. The supply must be accepted as presented by nature, or, if manifestly impure, with such purification as can be hastily effected. The senses have to be relied on for the determination of purity. If free from turbidity, color, odor, and taste other than the fresh impression produced on the palate by aëration and the presence of a small portion of inorganic salts, it is pronounced good. This is the popular opinion based upon the popular experience. The professional opinion must be more guarded. Collateral circumstances must be studied to impress it with more of scientific accuracy. If a careful survey of the surroundings appear to exclude the possibility of contamination, and if at the same time the results of experience be borne in mind, so far as they point out injurious effects from waters apparently pure, this primitive mode of water analysis becomes invaluable in the absence of more delicate methods.

In permanent camps, so essential is a pure supply to the health of the command, that it should be obtained, even if some other point less hygienically important, such as convenience to the base of operations, should have to be given up in its favor. Questions of transportation and finance should in such camps be subordinate to those affecting the health—that is, the efficiency of the army.

Potable waters contain mineral and organic substances, both of which may be present in limited proportions without exercising manifestly injurious effects. The former, indeed, in many instances, may be regarded as dietetic, presenting to the system materials which are needful to its well-being. When, however, they are present in excess, besides impairing the value of the water as a cleanser, they are liable to occasion enteric symptoms and renal irritation. These results, like those of other dietetic errors of short standing,.are easily controlled by correcting the fault in the dietary.

The inorganic constituents of ordinary waters consist of certain gases derived from the atmosphere and soil, such as oxygen, nitrogen, carbonic acid, and ammonia; of combinations of lime, magnesia, and the fixed alkalies with chlorine, carbonic, sulphuric, nitric, and nitrous acids, together with small proportions of iron, alumina, silica, and phosphates.

The oxygen dissolved in water is of value to it as a purifier. It promotes the changes which the elements of organic matter undergo in their passage from complex and deleterious to simple and innocuous forms.

In water, as in air, the nitrogen seems without active characteristics.

Carbonic acid gives sparkle to the water and impresses the palate pleasantly. Its presence in quantity is frequently accompanied by excess of lime. Boiling, by driving off the gas, precipitates the lime held in solution by its aid, and renders the water softer.

Ammonia in water is washed from the atmosphere by falling showers, in which case its presence is unimportant. But it may have been derived from the soil through which the water-supply has percolated, and as it is an ultimate product of the decomposition of organic matter, the signifi-

cance of its presence is dependent on its origin. Ammonia, harmless, with recent rainfalls to account for it, becomes a dangerous constituent when existing along with the organic substances from which it has been derived.

Potash and soda salts are not unwholesome unless present in quantities recognizable by the taste. Alkalinity can be so discovered; and, to be dangerous by their laxative properties, it is conceived that sulphates would require to be present in quantity appreciable by a delicate palate. Sodium chloride, however, has a significance dependent, like ammonia, on its derivation. It is a constant constituent, to the amount of one or two grains per gallon, in waters which have come in contact with the soil. Its presence in larger quantity requires investigation as to its origin. It is, above all others, the salt of the animal organism ; it is the salt of the excretions. It abounds in the sewage of camps which is committed to the soil, and its presence in the water-supply in unusual quantity must be satisfactorily accounted for before warrant can be given for the use of water so impregnated. Infiltration of sea-water, or percolation through beds of rock-salt and other chlorinated formations, disclaims injurious effects from chlorides, unless in unpalatable quantity. Lakes and ponds where the outflow is limited, and an equable water-level, mainly preserved by active surface evaporation, may become charged with innocent chlorides by concentration. The Jordan River, which empties the contents of Lake Utah into the Great Salt Lake, contains ten and a half grains of chloride of sodium per gallon, but is by no means an unpalatable or unhealthy water. If, however, the salt cannot be accounted for in some such manner, special attention to organic impurity is indicated.

Excess of alkaline earths in the water is productive of intestinal disorders. Other morbid processes are attributed to them, as vesical calculi and goitre ; but these have little interest to the camp hygienist, except in so far as tendency to disease implies deterioration of the system. In the form of carbonate they may exist in larger proportion without detriment than in other combinations.

The iron, alumina, silica, and phosphates are rarely of importance as deleterious agencies. Waters which have remained for some time in contact with a clay stratum are often impregnated with an odor somewhat similar to that of organic decomposition, which renders them unpalatable but not dangerous.

Nitrates and nitrites are of interest only as the remains of previously organized materials. Their presence necessitates an inquiry as to whether their origin is recent or remote. If recent, increased rapidity of flow may bring into the supply the unchanged principles from which they are derived. The organic impurities of such waters must be closely watched.

In reviewing the inorganic constituents of drinking water, it is seen that their bearing on the question of organic contamination is chiefly dwelt upon. The injury which they effect *per se* is as nothing to the dangers which may spring from their azotized connections.

Like the mineral substances, the organic matter may occasion gastric

and enteric disturbances, but unlike them it may be the source of disease which, when once introduced by the water, is propagated irrespective of it, and may destroy the efficiency of an army as quickly as it effects the destruction of the individual. Malarial fevers, dysentery, typhoid, cholera, yellow fever, the most formidable of camp diseases, have all been traced to impregnation of the water-supply. In the face of such possibilities the importance of the organic matter cannot be overrated. To the camp sanitarian water analysis is virtually the analysis of the organic contamination.

Inorganic salts are readily detected and estimated, and an opinion on their wholesomeness formed without doubt or hesitancy; but it is otherwise with the more dangerous constituent. Nothing is known of its composition, nothing of its characters, nothing of the poison, germ, or specificity which may attach to it in a given case. Its presence can be detected and its quantity approximately determined, but there is unfortunately no test for quality other than its effects on the system when ingested.

Experience of this nature teaches that vegetable matters, generally speaking, are less virulent than those of animal origin. The analysis of the organic contamination must therefore embrace an examination of everything which can throw light on its history or derivation, and thus, as seen above, the inorganic nitrates, nitrites, sodic chloride and ammonia become involved in the investigation.

Where facilities exist, an accurate determination of the inorganic constitution of the water should be made and recorded. For this purpose two or three gallons are required; and of course, in collecting the water, care must be taken to ensure that the sample contains nothing but what existed in the supply from which it was drawn.

In commencing the analysis the specimen bottles are permitted to stand for three days to effect the deposition of all suspended matters. The clear water is drawn off by syphon, and the sediment examined for living and decomposing organic matter.

In the meantime, on a filtered sample the hardness, total and permanent, is determined by soap-solution, and qualitative investigations instituted to note the presence or absence of the various substances which are expected in such waters, and to specify their combinations.

One or two litres, depending on the richness or poverty of the water in inorganic salts, are evaporated to dryness in a water-bath, and the residue weighed. It is then heated to destroy organic matter, care being taken that the temperature is not such as will induce changes in the minerals—calcination of chalk, deflagration of nitrates, decomposition of magnesian chloride, etc. After this process carbonate of ammonia is dropped on the residue to replace carbonic acid which may have been driven off, the ammonia is volatilized and the dried material weighed for the total quantity of inorganic solids in the water under examination. The difference between this and the previous weighing represents the destroyed organic matter.

The total solids are then boiled with dilute hydrochloric acid and water, and the insoluble silica filtered off, ignited, and weighed.

The acid solution is heated with ammonia in excess and the precipitated iron, alumina and phosphates separated, ignited, and weighed.

The removal of the lime from the alkaline filtrate is accomplished by precipitation with ammonia oxalate—the lime-salt being afterward decomposed by ignition, and weighed as chalk after treatment with carbonate of ammonia.

From the filtrate the magnesia is thrown down by ammonia and phosphate of soda, ignited strongly, and weighed as pyrophosphate.

One or two litres are treated with barium chloride in the presence of hydrochloric acid, and the precipitate allowed to settle for three days, when the greater portion of the water may be removed by syphon, and the sulphate collected on a filter, ignited, and weighed for the acid.

One-half to one litre is concentrated and the chlorine estimated by silver solution of known value.

A similar quantity is evaporated nearly to dryness and the carbonic acid determined by standard acid and alkaline solutions.

One or two litres are evaporated to a small bulk with enough of barium salt to remove the previously determined sulphuric acid ; well-washed lime is then added, and the boiling continued for a short time to separate magnesia. The solution is then filtered, and the dissolved calcium thrown down by carbonate and oxalate of ammonia. The filtrate is evaporated and ignited, but before weighing it must be redissolved and again treated with carbonate to remove the last of the lime. The alkali chlorides can now be weighed, the chlorine ascertained by silver solution, and the alkalies calculated therefrom.

Nitric acid, when present, is determined as ammonia by distillation with zinc, iron, and caustic soda.

An examination of this character is required to give scientific accuracy to an important item in the medical history of a camp. But in cases where time and appliances are not available, where the question is suddenly presented, and immediate answer demanded as to the wholesomeness of the inorganic constituents of a given sample, the medical officer can aim only at that degree of accuracy which will furnish a satisfactory solution to the point at issue. This can usually be attained, in the absence of balance, burettes, standard solutions, and time for their application, by the aid of a few reagents, with test-tubes, spirit-lamp, and small evaporating-dish. But the method is based on the experience of the individual in the processes of water analysis, and its accuracy dependent on practice and observation.

If 100 c.c. of the water be evaporated to dryness over the spirit-lamp, the quantity of the residuum may be expressed in grains per gallon by one who has often verified his estimate by the balance, while its appearance, its state of aggregation, whether layered over the capsule or left in the bottom by the last of the water, give hints as to its nature. Again, in heating to destroy organic matter, the development of the carbonaceous coloring from pale fawn to black, with evolution of odor, conveys as much information as the balance can furnish in a case where quality is

of so much greater import than quantity. The addition of a few drops of water, showing the manner of solution, corroborates the inferences from the manner in which the water left the residuum. Acidulation with hydrochloric acid conveys information, as the effervescence is greater or less, as it is mainly in the aqueous solution or advances in foam as the liquid is tilted over the less soluble film, or as it fails to dissolve until large excess of water is added.

If the acid solution be diluted to 10 c.c., and excess of ammonia added, alteration in tint indicates iron and alumina. On boiling this alkaline concentration with oxalate of ammonia the quantity of lime is determined. Two grains of carbonate per gallon thus precipitated give a non-granular opacity which is long in clearing. With four grains fine granules fall to the bottom, dusting it over, and leaving the supernatant liquid milky for a time. While with from six to ten, and upward, the precipitate becomes flaky and falls more readily, leaving the solution clear, and giving a basis for its estimation by its bulk in the bottom of the test-tube. Collateral experiment on a sample boiled to throw down the lime carbonate indicates the soluble calcium salts. Sulphuric acid is estimated by the varying density of the baryta cloudiness, or, the operator being familiar with the appreciable mistiness produced by one grain of acid per gallon, may dilute the sample with volumes of acid-free water until the one-grain reaction is attained. The silver-test for chlorine gives a blue haze with one grain, increasing through various degrees of opacity, until with eight grains minute particles begin to float, and with ten a precipitation of small flakes takes place in the milky solution. The soap-reactions, also, to those practised in their application, are of much value in hygienic quantitative determinations.

By such a series of experiments, occupying little more than the time required to evaporate 100 c.c. of water over a spirit-lamp, all practical questions relating to the inorganic constituents can be answered.

But rough approximations are valueless in the case of the organic matter. The quantity which may produce injurious effects, even in the absence of specific poison, is so small that in its estimation recourse should be had to the most delicate methods.

For route and other fugitive camps no estimation is possible. Reliance must be placed on color, taste, and odor to indicate the possibility of danger and the precautions needful. To detect odor a bottle half filled with the water is shaken, and the air with which the water has been, so to speak, washed, is submitted to examination.

The presence of organic matter insufficient to give odor is indicated by blackening during its ignition, by reduction of gold in terchloride solution, by decolorization of permanganate, etc. The last has been much used as a quantitative test, the amount of organic matter per gallon being expressed in grains of oxygen from permanganate required for its destruction.

But the most delicate test of the presence of organic substances, and at the same time their most accurate measure, is that which sanitary

science owes to Professors Wanklyn and Chapman. The nitrogen of the contamination is detected and determined as ammonia by the action of potassa and its permanganate. Ammonia pre-existing in the water must be removed before the application of the test; but as this gas is in many instances proportionate to the organic decomposition which has taken place in the water, its estimation becomes a formal part of the analysis.

The ammonia separated in either case is determined by Nessler's reagent. When a solution of mercuric iodide in iodide of potassium and potassa is added to a liquid containing ammonia, a reddish precipitate occurs; but, when traces only are present, a yellowish coloration is produced, varying from the palest straw tint to a dark brown. The depth of tint, by comparison with that produced in ammoniacal solutions of known strength, is the measure of the ammonia present. Flat-bottomed cylindrical test-glasses, about an inch in diameter and five or six inches high, with a mark at the 50 c.c. level, are convenient for instituting comparisons.

The Nessler solution is made by dissolving 3.5 grms. of iodide of potassium, and 1.6 of mercuric chloride, each in a little water, and adding the mercurial solution to the other until the saturation-point is reached, when the preparation is made up to 100 c.c. with concentrated solution of potassa.

The standard solution for comparison contains 31.5 mgrm. of ammonium chloride per litre, one cubic centimetre of which is equivalent to .01 mgrm. of ammonia.

In conducting the analysis a certain quantity, say 500 c.c., of the water is distilled from a litre retort connected with Liebig's apparatus, or some other means of effectually condensing the vapors. The distillate is collected in a test-glass, which, when filled to the 50 c.c. mark, is replaced by a second. To the distillate in the first glass two cubic centimetres of Nessler's solution are added and the tint noted. Two or three minutes only are required for the full development of the color. Experience enables the operator to give a guess at the strength of the ammoniacal solution which will match it. He therefore runs into a test-glass x c.c. of the standard ammonia, fills to 50 c.c. with distilled water, and adds 2 c.c. of the test-solution. If the coloration thus produced be too faint or too deep, the experiment must be repeated with $x + 1$, or $x - 1$ c.c., as seems required to match. In all cases where the proper tint is struck at the first trial it is well to guard results with a weaker solution on one side and a stronger on the other.

The tints are well defined for each .01 mgrm. of ammonia present; and as they are perfectly clear and transparent, the distillation freeing the sample from inorganic salts which would interfere with the purity of the color, there is no hesitation or uncertainty in decision.

When the ammonia in the distillate is comparatively large the coloration may be too dark for accurate discrimination; in this instance one-half, one-fourth, or less, is taken, diluted to 50 c.c., and the color of the dilution matched for quantitative estimate.

If the free ammonia be minute in quantity its volatility may carry it

all over with the first 50 c.c., in which case the second test-glass of distillate will give no color with Nessler's solution. But, as it often happens that the second and third test-glasses will contain decreasing quantities, they must be estimated, and the distillation continued until 50 c.c. are collected, which show perfect freedom from ammoniacal taint.

There is then added to the residual water in the retort 10 grms. of caustic potash and .400 grms. of permanganate, dissolved in distilled water which has been proved free from ammonia, and the distillation is continued. Under the action of these chemicals the nitrogen of organic matter is converted into ammonia, which is condensed and estimated, as was the free ammonia, in successive portions of 50 c.c. each, until no more is evolved. Here, also, the greater part of the ammonia drops into the first glass, and, if in large quantity, may require dilution for discrimination of tint.

From the total of ammonia in the successive test-glasses the amount per litre or gallon is calculated. English authorities record their results in milligrammes per litre, or, which is the same thing, in parts per million. If 500 c.c. have been placed in the retort, multiplication of the ammonia by 2 expresses it in accordance with this system.

This test, so sensitive to the presence and accurate in the determination of nitrogenous matters, gives, unfortunately, no hints as to their toxic qualities. These must be drawn from other considerations. A study of the possible sources of contamination may sometimes exclude an animal derivation. Absence of free ammonia, nitrates, nitrites, and chlorides will also exclude it. Presence of much free ammonia, with organic ammonia small, indicates influx of rain. Free ammonia small and organic matters large, give, in the absence of nitrites, a recent vegetable origin to the contamination. Free and organic ammonia, both large, in the absence of rainfall, nitrites and chlorides, is indicative of vegetable impurity and decomposition. Presence of ammonia, free and albuminoid, with nitrites, points to danger from animal matter; and the conjunction of ammonia, chlorine and organic matter, implies sewage infiltration either by gross contamination of the soil or the establishment of sink-connections.

While the ammonia distillations are progressing the operator can determine the presence or absence of nitric and nitrous acids and estimate the chlorine. Sprengel's test for nitrates is the best for the military surgeon: 20 or 30 c.c. of the water are evaporated to dryness, and a drop of the test-solution, consisting of one part of carbolic acid, four of sulphuric, and two of water, is added to the dried residue, producing a reddish-brown coloration when nitric acid is present. Nitrous acid is detected by the blue color when iodine is liberated in an iodized starch solution. Chlorine is estimated volumetrically by a decinormal or other standard solution of silver.

Any or all of these inorganic forms of matter may be present in a water without detriment to its quality, provided organic substances do not coexist. Their organic origin is so remote as to deprive their presence of serious meaning. But when a trace of vegetable or animal matter

accompanies them, their presence adds to the suspicion with which the water should be regarded. Indeed, certain proportions of organic ammonia distilled from the sample should condemn it irrespective of all other considerations.

In turbid waters the organic matter held in suspension is of interest in this connection, as in the absence of subsidence or filtration it may be as harmful as when dissolved. Moreover, it is present under circumstances favorable to its disintegration and solution.

Sediment varies in weight per gallon, chiefly owing to its inorganic constituents. The microscope gives information concerning them, and also with regard to the living and dead organized material which may be present. Few waters are free from infusoria when a drop of the sediment is examined, but no practical generalizations have been reached. All are connected with impurity. The writer is induced to believe that a prominence of living vegetation on the microscopic field is more likely to correspond with a wholesome water than is the case with any other organic appearance.

While a water may be dangerous from dissolved organic matter in the absence of sediment or of nitrogenous substances in the sediment, the presence of the latter may be regarded as evidence of its existence in solution, not so much as a consequence, but as a coincident fact. As the result of many experiments on Western streams, one-quarter of a grain of organic sediment per gallon (obtained by ignition and the balance) led to the expectation of organic ammonia in quantity sufficient to throw suspicion on the wholesomeness of the water.

But, having pronounced upon it in the first instance, the duty of the medical officer in relation to the water-supply has only commenced. Constant watchfulness is required to guard against contamination, either in source or distribution, and frequent examinations to detect deterioration before it is forced upon notice by the occurrence of preventable disease.

The sanitary bearing of any variation in its constituents must be determined, but, above all, the organic contamination must be noted at intervals, and its increase carefully investigated and traced to its source.

Every health officer will acknowledge the necessity of thus guarding the water-supply in camps where soil-pollution is the inevitable consequence of continued occupation, and where all formidable outbreaks of disease are connected with organic impurity. Yet this care is seldom bestowed, chiefly from an impression that the organic matter lies beyond the scope of our present means of research. It is true its quality, its action on the human system, cannot be predicated from the results of chemical examination; but, when certain limits of organic impregnation can be defined, within which experience shows the water-supply to be in general innocent and beyond which there is liability to disease, the method which can accurately state the position of a given water with regard to those limits should not be overlooked. The process occupies but little

time, and, while combining delicacy with accuracy, its simplicity—a distillation and matching of well-marked tints—excludes the likelihood of manipulative errors.

British analysts are guided in their decisions as to the allowable limit of impurity in potable waters by the opinion of Wanklyn, who looks upon albuminoid ammonia above .10 per million as a suspicious sign, and condemns water containing over .15 parts. Most of the waters condemned by these sanitary officers are from wells which on examination show sewage infiltration, rivers which are polluted by settlements nearer their source, and waters generally on which the suspicion of typhoid, diphtheria, or other animal poison has been cast. Prof. Wanklyn's limit must therefore be regarded as applying to animal contamination. It is the limit which in our country we ought to accept in the denser settlements, and in every case where an animal origin to the organic matter is indicated by careful survey or chemical analysis.

Not that typhoid developments are to be expected in every case where the organic ammonia exceeds this limit, but that experience shows greater probability of their occurrence with a water thus impregnated,—the animal poison of typhoid being more likely to be present with a large than with a small organic pollution.

But when animal matter is excluded by the circumstances of the case, this limit must be extended. The waters of the purest mountain streams in our unsettled West, where animal contamination is an impossibility, contain .14 parts of organic ammonia. At other times they may yield .20, .25, or more parts per million and yet be regarded as comparatively innocent. In 1875, when the writer first investigated the organic impurity of these waters, no doubt was thrown upon their wholesomeness until .50 was reached, when the letter of the medical officer (Dr. Hoff, U.S.A., at Fort Sanders, Wyoming Territory), who forwarded the sample, spoke of low fevers which had existed at some previous time and had been attributed by the settlers to impurity in the water. In reporting at the time on these analyses to the Surgeon-General's Office, the following language was used:

"What is the cause of the large amount of organic matter in our Western streams as compared with that in the waters of Britain? These streams ought to be pure, if pure water is to be found in nature, as they run through no populous districts, and are thus free from the sources of contamination against which sanitary officers are most on guard. They spring from a cleft in the rocks, are mostly rapid in their course until they reach the plains, and are fed by the rainfall and the melting snows. There seems nothing left by way of explanation than the wildness of the country through which they run. In England the fields are fenced in and the soil cultivated to the very banks of the streams, the woods are well kept, and the swamps drained and reclaimed; but here there is no cultivation; vegetation lives, and, instead of being garnered up, dies and decays. The forest trees fall and rot where they fall. I have been in the Uintah Mountains where are the sources of Black's Fork, and among the pines

covering the slopes of the ridge there are more fallen trees in all stages of decay than living ones in those untouched forests. Through such dead vegetation the streams have to force their way, and it would be singular indeed if they did not take up a portion of the soluble organic matter. But, in addition, in the tangled willow-growth of the valleys, where, as in the forests, the growth of to-day rises from the decay of ages, the beaver dams up the stream, and vast masses of water are stagnated, to dissolve the dead vegetable tissues, and find their way by slow degrees back into the beds of the running water.

"That the dissolved organic matter is vegetable in its origin, is also shown by the absence of chlorides and nitrites, and that it is recent by the frequent absence of ammonia.

". . . Of the waters given above, all would be condemned by British authorities, with the exception of the Omaha well (.10 parts), and even it would be looked upon with suspicion. Such waters in England would be the centres of so many typhoid fever ranges, while here there are but a few sporadic cases recorded. And now, how comes it that the large amount of organic matter in our streams is productive of so little injury to the people using them? Undoubtedly because of the character of the organic matter. It is vegetable in its nature. Then we must assume that vegetable matter dissolved in water is less hurtful than that of animal origin, and that, instead of .07 being suspicious and twice this amount dangerous, which may apply to animal matter, .30 is allowable, .40 suspicious, and .50 dangerous, as at Fort Sanders we are first confronted with a possibility of typhoid fever in connection with the water-supply."

But this estimate of the allowable limit of vegetable matter was soon shown to be too high. Continued observation of the organic impurity, and of the health of the communities making use of the waters, demonstrated the connection between the adynamic remittent of those regions and the impure water-supply.

In studying mountain fever clinically, its malarial origin was recognized, and investigation led away from any suspicion of the water to a search for obscure causes of malaria. Innocent mountain valleys, which never originated a chill other than that from severity of weather, were looked upon with suspicion as the probable source of a malarial disease as dangerous to the individual as is typhoid fever. Yet some facts connected with the history of the disease, such as its occurrence with the thermometer at zero or below, seemed absolutely inconsistent with a malarial origin. Dr. Roberts Bartholow, in his report from Fort Bridger, Wyoming, for September, 1858, gives a good picture of the disease, and concludes his reference to the cause thus: "In the present state of our knowledge upon the subject of this aërial poison, it must be confessed that the cause of this fever must be sought elsewhere than in the theory of a local poison. The occurrence of this fever may be plausibly accounted for upon the theory of latent malaria becoming sensible in a rarefied atmosphere and at a considerable elevation." Hertz, writing for Ziemssen's Cyclo-

pædia[1] at a later date, thus expresses the uncertainty: "Whether similar conditions will be found to exist explaining the origin of mountain fever, such as a rocky soil with clefts and chasms containing damp and decaying detritus, is not yet determined."

From a clinical point of view, the cause of the disease was surrounded with mystery. But these perplexities vanished when variations in the organic impurity of the water were shown to correspond with variations in the intensity and prevalence of the disease.[2]

As animal matter, in certain stages of its decomposition or enveloping specific germs, gives expression to its presence in the system by the developments of typhoid fever, so vegetable matter, in certain stages of its decomposition or enveloping specific germs, gives rise to an adynamic remittent, for which the writer has suggested the name of *aquamalarial fever*.

Viewed in its connection with this affection, the organic ammonia should not exceed .16 parts, for, when .20 is reached, the disease makes its appearance and becomes more pernicious in individual cases as the amount increases. Not that aquamalarial developments are to be expected in every case where the organic ammonia exceeds this limit, but that experience shows a greater probability of their occurrence with a water thus impregnated,—malaria being more likely to be present with a large than with a small vegetable contamination.

All natural waters have a history which indicates in general terms the character of their probable insalubrity. Arising by surface evaporation, their vapors pervade the atmosphere, until, having reached a certain point of cumulation, some electric or other change in surrounding conditions causes condensation and precipitation, as rain or snow. Having thus reached the earth, they divide into a superficial and a deeper layer. The former is collected in such natural reservoirs as rocky tanks and clay-bottomed basins, or more generally is drained off by shallow surface courses into the main river-beds. The waters of the latter penetrate the soil to a greater or less depth where they stagnate as on the surface, or more generally drain to lower levels, where some break in the crust permits their reappearance as springs which channel out surface-courses and become the radicles of the running streams.

In their progress through the air as vapor and cloud the waters become impregnated with many soluble impurities, and in their fall as rain, and especially as snow, they entangle and carry down all the organic material which is diffused through the atmosphere. That the rainfall is a purifier is manifest to the senses, but chemical analysis is required to give adequate expression to the extent of the purification. The rainfall on the Rocky Mountains, where contamination from any but natural processes is thoroughly excluded, contains .16 parts per million of organic ammonia.

[1] Vol. II., p. 567, New York, 1875.

[2] Mountain Fever and Malarious Waters: Smart, in Am. Jour. Med. Sciences, January, 1878.

The snow, which falls in heavy flakes and forms the bulk of the annual snow-precipitation, gives from .40 to .60 parts, depending, no doubt, upon the condition of the aërial regions through which the clouds have swept previous to and during their earthward fall. Snow collected on the Wasatch and Uintah Mountains, in Utah and Wyoming, yielded these amounts.

Viewing cloud-precipitation as a purifier, all surface waters—pools, ponds, tanks, snow-water streams and rain-water courses—have, of necessity, an organic impregnation proportionate to the impurity of the atmosphere through which they have circulated, while their inorganic constituents, in consequence of slight contact with the soil, may in general be overlooked.

On the other hand, in their percolation or filtration through the surface-layers of the earth, this organic impurity is removed; but, in the meantime, inorganic salts have been dissolved to an extent dependent on the character of the strata. On their reappearance as springs, the aërial contamination is less liable to interfere with the wholesomeness of the supply than are its inorganic constituents. Deep wells may be regarded as artificial springs. In shallow wells, soluble strata and insufficient filtration indicate the possibility of inorganic unwholesomeness and vegetable impurity. River waters are variable in quality in proportion as spring or surface water contributes to their volume. Each dilutes the other. In them there is neither so much mineral matter as in the springs, nor so much of the air-swept organic taint as in the rain and snow. During seasons of flood the vegetable contamination is augmented, chiefly from the increased proportion of the surface water, but in part, no doubt, to the disintegration and solution of organic matter carried down in their turbidity. Black's Fork, Wyoming Territory, with an impurity of .14, when most free from surface admixture, gave .28 parts per million when swollen by melting snows. The Little Wind River of Wyoming, a stream running over its rocky bed, clear and fresh from the snow of the mountains, with only two and a quarter grains per gallon of inorganic matters, gave .34 parts of organic ammonia. The North Platte River, in various stages of flood and turbidity, yielded from .30 to .50 parts per million. And so of other streams.

Deep wells and springs furnish a water in general free from the probability of aquamalarial or typhoid infection; but their use may be contraindicated by the presence of inorganic matters.

Shallow wells have aquamalarial possibilities which must not be overlooked, and, in addition, are liable to animal contamination from a surcharged soil.

Rivers are more liable than the wells last mentioned to be the source of aquamalarial disease, but are less dangerous, generally speaking, from animal matter, owing to dilution and rapid oxidation.

Surface ponds are certainly unwholesome from their vegetable impregnation, and are exposed to possibilities of animal poison. Concentration by evaporation may render them still more deleterious.

Snow-water, pure and fresh as it appears in its course from the mountains, is dangerous on account of vegetable impurity. "There has long been an opinion that snow-water is unwholesome."[1] The writer is indebted to Dr. J. J. Milhau, of New York city, recently Surgeon U.S.A., for an illustrative specimen of the experience which gave birth to such an opinion. As this matter is still *sub judice*, and its bearing manifest on camp water-supply and camp diseases, no hesitation is felt in quoting Dr. Milhau's report, particularly as the edition[2] in which it appeared was limited, published as it was at the commencement of our late war. Its every word, written twenty years ago, points to the snow-water as the origin of the fever in camp; yet its author's arraignment of the water, qualified as it is, must be accepted as professionally bold, in the absence of a knowledge of the amount of its organic impregnation, and in the face of its apparent absolute purity.

"On the 1st of July, 1858, the first column Utah forces, consisting of Company A, Engineers, and six companies of the Sixth Infantry, in all 19 officers and 348 enlisted men, under command of Lieut.-Col. Andrews, Sixth Infantry, encamped at Elk, or Butte Creek, near the base of Medicine Bow Butte, lat. 41° 41′ N., long. 106° 36′ W.; elevation above level of sea about 7,000 feet.

"The camp was pitched in a grassy valley watered by a number of small streams coming directly from the melting snows on the mountains. The water was icy cold, clear, and perfectly free from the alkaline taste generally found in the waters of that region. The neighboring mountain was clothed with a dense forest of spruce, fir, and pine, and its upper third covered with snow.

"As this locality presented every advantage for a good and healthy camp, the command made a halt for five days, for the purpose of recruiting and refitting. On the 30th of June a working-party of ninety men was sent on ahead to make the road on Stansbury's trail, through Bridger's Pass.

"On the fourth day of the halt a severe form of fever very unexpectedly made its appearance in the command, which in four days placed thirty-five men on the sick report, and news was sent back from the working-party that twenty of the ninety men were unfit for duty on account of this disease.

"The camp was broken up and the command continued its line of march, making easy marches and frequent halts; but the disease continued for nearly three weeks, and until the column reached Green River. Five officers and one hundred and five enlisted men were treated for the disease, besides a large number of teamsters and herders, of whom no record was kept.

"*Description of the disease—Name.*—This disease is called mountain

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[1] E. A. Parkes: Manual of Practical Hygiene, p. 9, London, 1866.

[2] Statistical Report on the Sickness and Mortality in the Army of the United States. By R. H. Coolidge, A. S., U.S.A. Pp. 304–5, Washington, 1860.

fever by the trappers and mountain-men, who state that they are frequently affected with it in the spring, when following up the rivers to their sources in the mountains for the purpose of trapping beaver. This is in May and June, when the ice in the streams breaks up and the snow commences melting. These trappers also state that the Indians are subject to the same disease when roaming through the mountains in the spring."

The symptoms as given in the report are omitted as irrelevant to the point at issue.

"*Cause.*—When the disease showed itself the command was encamped in a locality which seemed free from all local cause of disease ; it attacked both officers and men with equal violence ; those who had marched, and those who had ridden ; those who had been on guard and on fatigue, and those whose duty was light ; those who had worked in the water making roads and crossing trains, and those who had remained in camp comparatively idle ; all appeared equally subject to the influence of the disease. The first case that occurred was that of a sergeant who had been hunting in the mountain, and, becoming much overheated and thirsty, drank freely of the melting snow. The next two cases occurred in men who had been burning charcoal in the mountain. I naturally concluded that the cause was to be found in the mountain; but when the disease spread generally throughout the command, without reference to the nature of their exposure, I was at a loss to find a satisfactory cause. The water used by the troops came directly from the melting snow on the mountains. The temperature in camp ranged from 22° F. at night to nearly 90° in the day, and I think that the combined influence of hot days, cold nights, and the use of snow-water was one element in the cause producing the disease. The trappers say that this fever is a kind of seasoning to the mountain air, and I am disposed to look upon it as a fever of acclimation."

Many outbreaks of fever connected with the use of snow-water have been observed in the West by our medical officers, but in none of the reported cases have the conditions affecting the command been so clearly stated as in that quoted.

Dr. Charles Brewer, U.S.A., in the volume from which the above extract is taken, is reported, p. 313, as saying that: "Mountaineers, to whose long observation and experience in the wilds some attention is due, attribute the origin of the so-called mountain fever to the melting of snows and the drinking of snow-water."

Snow-water, therefore, pure as it seems, must not be accepted as innocent until its freedom from organic ammonia in deleterious or suspicious quantity has been proved. This, in fact, should be the test of all camp water-supply where contraindications to its use are not furnished by its sensible properties. An amount of organic ammonia in excess of .20 parts per million demands a radical change in the water-supply, either by the abandonment of river or other surface waters in favor of wells or springs, or by their purification by filtration on a large scale. Small charcoal-

filters are valuable for individual use on the march or in the shifting camps of active service, but are inadequate to meet the general question of camp supply. In such cases, also, simple boiling, or boiling with tea, destroys organic matter, coagulating albuminoids and precipitating lime. Alum and permanganate are also used as purifiers.

A pure and adequate supply having been found, no precaution should be omitted to preserve it in its natural purity. On rivers, points must be indicated for washing, and due care taken that the supply be not polluted for camps on a lower level. Wells require constant supervision lest they be tainted by sewage seams or surface washings. They should be walled in and frequently inspected. In the experience of the writer an unwalled well in the public square of Tucson, Arizona, contained the decomposing body of a man who had stumbled into it four or five days before the source of the organic taint was discovered. In a more recent case an officer applied for permanganate to drop into a cistern in which subsequent inspection discovered the putrefying body of a cat. Cases such as these indicate the necessity for repeated inspections of the water-supply, irrespective of that chemical examination which has, in this section, been so strongly urged.

SECTION VI.

ON THE CAMP KITCHEN AND COMMISSARIAT.

The food-supply is furnished by the Subsistence Department, which is responsible for quality. Quantity is defined by the Regulations. Its due preparation for consumption lies with the consumers.

As the soldier in camp is either engaged in active duties, or resting and repairing waste before entering on a new campaign, his ration or daily allowance of food should be liberal. The average appetite of the command is the theoretical measure of this allowance, but in practice this must be exceeded to afford a margin or surplus for contingencies. In the absence of such a margin there is liability to disease requiring special expenditures of food and other supplies by the medical department, which, with loss of efficiency and the accidents which may result from that loss, sum up the high price paid by governments for entailing suffering on their troops by a deficient dietary.

Overfeeding has its dangers, but they are limited and trifling compared with those which attend the opposite condition. The system can throw off the small surplus, but deficiency leaves some tissue unrepaired and power proportionately lessened. If the soldier is a machine, as he has sometimes been called, he should be kept in good repair and well supplied with motive power. Unrepaired losses weaken the system and render it prone to succumb to the morbific influences and exposures of camps and campaigning. Armies have been disarmed by a deficient dietary, but

never by the overfeeding consequent on the establishment of a liberal ration.

Scientific investigations into the quantities of food used by mankind under varying conditions of labor and repose have shown that about fifteen ounces avoirdupois of water-free food are required for what Dr. Playfair calls *subsistence diet*, to carry on the internal work of the body. Any labor other than this organic work—any outward manifestation of force, demands an increase of the diet over 15 oz. proportioned to the amount of force expended. The diet of a healthy adult in moderate and usual exercise will contain, according to Prof. Parkes, on an average in twenty-four hours, 23 oz., while under great exertion it will be raised to from 26 to 30 oz. and over. Dr. Playfair's estimate is much similar; with easy work the male adult requires 25 oz., in active work, 28.9 oz.

The soldier's ration should manifestly contain not less than 30 oz. of water-free food, to fit him for the active work which requires that amount of reparative supply, and to lay to his credit during periods of temporary respite from labor a fund on the books of the Subsistence Department, on which he can draw when the exigencies of service require the increased exertion which is incompatible with the ordinary ration.

Furthermore, these 30 oz. should consist of albuminoids, fatty, saccharine, amylaceous, and saline substances in certain proportions. Individual and national habits moulded upon taste, climate, abundance of particular supplies, etc., cause much variation in the proportions in the extreme cases. But the average which fits the necessities of the system under ordinary circumstances has been determined, and is given by Dr. Parkes, as .60 of fat, and from 2.5 to 3.5 of starches, to each part of nitrogenous food. The thirty ounces of the ration thus distributed, would give:

To albuminates	5.69	= 30 oz.
" fats	3.41	
" starches	19.90	
" salts	1.00	

Having thus gathered, from those writers who have devoted most attention to the subject, the data by which we may judge of the sufficiency of a given dietary, the ration, as it is usually issued in our camps, may be investigated.

In the selection of the articles of the camp supply, price, portability, and permanence, or non-liability to deterioration, enter as primary considerations. Meat and bread are the staples, but the necessities of camp-life require that the latter be hard bread or biscuit, and that the former be salted, if it cannot accompany on the hoof the movements of the command. Among the vegetable products available for camp use are beans, peas, rice, corn-meal, pickles, dried fruits, and desiccated vegetables. Coffee, sugar, and salt are valuable portions of the camp food-supply.

The camp or active service ration of the United States army consists, as usually issued, of:

12 oz. pork or bacon, *or* 20 oz. fresh beef.	Generally issued in the proportion $\frac{1}{3}$ pork and $\frac{2}{3}$ beef, or 3 days' pork in 10 days' rations.
16 oz. hard bread.	
2.4 oz. beans or peas, *or* 1.6 oz. rice or hominy.	Beans generally issued; rice occasionally; peas and hominy seldom.
1.6 oz. green coffee, *or* 1.28 oz. roasted coffee, *or* .24 oz. tea.	Green coffee the usual issue.
2.4 oz. sugar.	
.04 qts. vinegar.	
.6 oz. salt.	
.04 oz. pepper.	

To these are added .64 oz. soap and .2 oz. candles, but they do not enter into the present question.

The nutritive value of this ration is as follows:

Albuminates	4.99
Fats	4.09
Starches	15.26
Salts	1.23
Oz. avoir.,	25.57

Comparing this with the model ration there is found to be a deficiency of nitrogenous and amylaceous substances, and a slight excess of fat. If the last be placed to the credit of the deficient starches in proportion to its heat-giving powers, .68 fat being the equivalent of 1.63 starch, the above valuation is simplified by showing only its deficiency, thus:

Albuminates	4.99;	deficiency, .70 oz.
Fats	3.41	
Starches	16.89;	deficiency, 3.01 oz.
Salts	1.23	
	26.52 oz. avoir.	

Our ration, therefore, while amply sufficient for easy labor, sustaining even an approach to hard work, is inconsistent with active service and wholly inadequate to carry the soldier uninjured over the frequent toilsome passages of a campaign. It is true its nutritive value is greater than that of the ration furnished by some governments; but the sufficiency of one diet cannot be proved by the insufficiency of another. The British soldier has 24.33 oz. as compared with our 26.52 oz.

An additional per diem to the diet of the individual is needful in our camps to keep the soldier at his maximum of strength, the addition con-

sisting of three-fourths oz. avoir. nitrogenous and three oz. carbonaceous material.

So far quantity only has been considered, but after a time variety comes to have an importance as great. Malnutrition arises from sameness of diet as surely as from deficient quantity. The complex character of the organic tissues requires that their reparative material be gathered from many sources. The distaste which follows the use of an unvaried dietary, however well arranged as to its carbonaceous and azotized proportions, shows that it does not fulfil all the requirements of the system. Something is wanting. The deficiency may be in some form of oil, sugar, or starch, in the salts of an organic acid, or in the mineral matter in more or less organic and essential combination with some albuminoid. Something is required to perfect certain of the tissues, and its want after a time is expressed by distaste for the diet and a longing for change, as the want of food in general is expressed by appetite or the sense of hunger.

Experience has shown the field of variation consistent with apparently healthy nutrition, and can point out the dangers attendant on a limitation of that field.

The framers of the ration undoubtedly conceived that they had provided the nitrogen and carbon sufficient for all emergencies. In this they were mistaken, and the mistake renders their provision for variation of the diet of no effect. Savings on any part of the ration are to be traded off for other articles of equal money value. If the men of a company do not use their beans, the value of the saved beans can be drawn in desiccated vegetables, dried fruit, etc. Every part of the ration has its money value, and the value of the unused parts constitutes a company fund to be applied by the company commander in varying the diet or in increasing the quantity of a deficient article.

Most of the savings are made on the bacon, which has been shown above to be in excess of the wants of the system; and as has been well remarked by Dr. Perin, U.S.A., in his report on this subject to the Surgeon-General,[1] "It may be added also that here is the origin of the exaggerated idea that the army ration is so abundant that the men cannot consume it."

But on active service what is saved on fat has to be spent in the purchase of flour, and all additions or extras to the diet have to come from the private funds of the soldier.

In some cases, with judicious company commanders, easy work and cheap vegetable markets, the fund raised on the present ration may suffice for all the needs of the command. But this is not enough. It should suffice for *all* commands, and not alone for the few exceptionally favored. Nor should these cases be brought forward as proof of the sufficiency of the ration, and of the neglect or carelessness of company officers whose men are harder worked and less favorably situated as to country produce.

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[1] Quoted in Circular No. 8: Report on the Hygiene of the United States Army, Washington, D. C., 1875.

In permanent camps—camps of occupation, such as are the various posts scattered throughout our Indian country—company gardens can frequently be cultivated, and a supply of fresh vegetables secured in their season, with pickles for winter use. Again, in many camps the produce of hunting and fishing parties varies the diet and saves the regulation ration as a fund for further variation when a market is available. These circumstances have combined to obscure the insufficiency of the ration.

Drs. Perin and McParlin, U.S.A., ventilated this subject in 1875, and the case in their report is stronger than the one above presented, inasmuch as they deal primarily with the barrack or peace issue of 18 oz. of soft bread, as against the more nutritive 16 oz. hard bread of the field or camp ration.

Since the date of their report an official acknowledgment has been given of the insufficiency of the soft bread ration, when unaided by the produce of company gardens, by an order authorizing its increase to 22 oz. at posts where vegetables cannot be raised, the increase being evidently intended for their purchase, as bread cannot take the place of fresh vegetables in the dietary. But this, which makes the barrack ration 24.05 oz. water-free food, instead of 21.65, is manifestly inadequate, outside of the consideration that where vegetables cannot be raised they are necessarily high-priced.

If the ration recommended by Drs. Perin and McParlin were adopted, one varying from 27.98 to 33.61 oz. avoir. according to the method of its issue, the extra ounces would tend to relieve the medical department from the care of so many scurvy cases annually, and prevent the immense amount of deterioration of system which must coincide in camps with the existence of *one* case marked *scurvy* on the records. Dr. Billings gives, in this connection, a statement of the cases of scurvy in the army, which, when summed up, shows for the years 1868 to '74 respectively, the numbers 133, 199, 87, 86, 61, 36, and 33. The decrease in the latter years is owing to increased cultivation of vegetables in company gardens. No other argument than this list is required to show the inadequacy of the ration to secure a proper variation of the diet by saving and exchange.

The experience of the writer has demonstrated the existence of a general scorbutic taint among troops supplied with the regulation ration and with more than the average home-growth of vegetables—an enervating taint which saps efficiency without appearing as scurvy on the medical registers. He has, therefore, in view of what has been stated regarding diet, no hesitation in saying that the issue to the soldier in permanent camps, on a peace or soft-bread ration, should not be less than 30 oz. avoir. of properly constituted water-free food, and that the field, war, or hard-bread ration should consist of 35 oz., to meet emergencies and afford a sure margin for the purchase of those vegetables which the nature of their service prevents the troops from raising.

Were vegetable markets and grocery stores of necessity next-door neighbors to our camps, the constituents of the ration furnished by the

Subsistence Department, outside of the main supplies of bread and meat, would have no interest beyond their money value. But such stores are generally beyond the reach of camps, and when they do exist their prices are graded on the scarcity of the article. When a thing is most wanted its value is greatest. A dollar a pound for sugar has been asked by traders when the subsistence supply failed on account of accident to transportation.

It follows that the ration issued to the troops ought to constitute, *of itself* and independent of fund purchases, a full and complete, if not very varied dietary. Since the late war the supply department has kept on hand for sale a number of extra articles, dried and canned fruits and vegetables, pickles, etc. But it is questionable if the purchasable articles would be on hand in war times, when difficulty is frequently experienced in having the articles of issue on the camp-ground. Potatoes, dried apples and peaches, pickled cabbage and onions, and lime-juice, should, therefore, form a formal part of the ration, and be transported and issued with the same regularity as is customary in the case of hard bread and bacon, coffee and sugar. The one series are as needful to the health and efficiency of the command as the other, and the fact should be officially recognized by their embodiment in the ration.

Concerning the quality of the food supply the same rules govern which hold good in civil life. Flour may be musty, hard bread mouldy and damp ; and so of the other articles. Diseased meat has to be condemned to prevent the gastro-intestinal irritation and general prostration which may follow its use.

The fresh meat of camp is usually poor in quality, tough, and with a large proportion of bone, from insufficient feeding and hard driving of the subsistence herd. When men have been on salt rations for some time the return to a fresh-meat issue is often associated with diarrhœa. This has been attributed to the quality of the meat, but old soldiers recognize it as the result of over-appetite for the fresh ration, and avoid the disease by moderation. Yet it is questionable if overfeeding will explain all the cases. It is to be noted that tainted meat is especially dangerous in camp, where unsuspected scurvy may predispose to diarrhœal and dysenteric troubles.

Hard bread, when insufficiently masticated, is liable to induce intestinal disorder. A favorite dish during field service is composed of the bread slightly softened by dipping in water, and then fried in pork-fat. There are few army medical officers whose experience does not embrace ministrations to the colicky sufferings of young soldiers who have satisfied the camp appetite on this dish.

Troops soon get tired of the hard-bread ration, and the relish with which a return to fresh bread is received has been thought to indicate that it better satisfies the wants of the system. The case is complicated, however. Hard bread coincides with privations, danger, and hard work, while soft-bread issues mean rest in camp, fresh meat, and possible extras, refits of clothing, letters from home, and many other desirable objects.

The argument against the hard bread cannot be viewed as satisfactorily established.

But certain it is that it requires greater digestive effort to effect its reduction. The vacuolation of fermented bread facilitates its assimilation, and for this reason alone it should be issued on all opportunities. The Subsistence Department ought to include portable ovens in its field outfit, and trained employees to make use of them.

Efforts have been made in various armies to introduce a water-free food in the form of meat-biscuits, sausages, etc., as more convenient for field service than the items of the ration. This the writer conceives to be a step in the wrong direction. A knowledge of the necessity for a full and varied diet, varied in manner of presentation as well as in material, condemns all suggestions which do not tend to increase the variation. A personal experience of six days on dried beef (charqui), pinole and sugar, confirms this reasoning. The pinole is a mixture of wheat and corn, roasted and coarsely ground. It was eaten as a brose, or thick paste, with sugar and water. After their experience of this concentrated diet, the pork and hard-bread ration was hailed by the men as a return to civilization and good times.

On the other hand, attempts at the conservation of food-elements for itemized supply are to be encouraged. Pickling, canning, with various degrees of concentration, even desiccation, are valuable methods of preservation Desiccated vegetables have not been fairly tried. They are currently reported as less valuable than the fresh article. How much of this deterioration is due to the drying process, and how much to kitchen manipulation, are unsettled questions. Company cooks, unless specially instructed, can dissolve out antiscorbutic virtues and throw them away as wash-water.

Alcoholic liquors form no part of the soldier's ration. That there are occasions on which they might be of use in an active campaign is undoubted, either as makeshifts for a deficient ration, or to gain a point by temporary stimulus at the risk of subsequent depression; but, under ordinary circumstances, in camp as in civil life, they are best relegated to the prescription of the physician and surgeon. Camp hygiene requires their absolute banishment from the lines. The medical and court-martial records of the week after pay-day, in all camps where whiskey can be procured, furnish data sufficient for insistance on their exclusion as the cause of much disease and many injuries and accidental deaths.

Since a certain degree of sameness necessarily attaches to the most liberal governmental issue of food, any method of preparation which enlarges the scope of its nutritive qualities is valuable. Experience shows that variety in cooking answers many of the purposes of variety of diet. Whether this is dependent on changes in the albuminoids, by differences in heat, or results from physiological stimulation of the digestive secretions, is of small consequence in this argument. But the necessity for a good cook in the company kitchen is obvious.

Some military officers hold that trained cooks should prepare the ration, and that the soldier should only be called upon to dispose of it. But,

as in field service every man may be thrown on his own resources for the preparation of his food, a familiarity with some of the simpler methods of practical cookery is desirable. Our Army Regulations take it for granted that every soldier is a competent cook, and provide for the cooking of the ration by rotation—each man serving in the kitchen for ten days. Practically, this regulation is a dead letter. Company commanders assign the man best fitted for the position to permanent duty as cook, and send the others in rotation, for ten days each, as assistants. By this plan the men have the best skill which the command affords in preparing their food and in economizing for company fund, while at the same time a familiarity with kitchen processes is disseminated. That this is the best method is proved by its universality in our service, in spite of regulations to the contrary. It frequently occurs, however, that the best skill afforded by the command is by no means such as to fit its possessor for so responsible a position. To provide for which a training-school should be established in connection with the principal recruiting depôt, where men who have a liking for the work could qualify as cooks, and carry a competent kitchen knowledge into the army. Not that these men should have the special position of cook guaranteed them, as this might interfere with their thorough subjection to company discipline. It would suffice that extra pay be given them for their services while they held the position by ability and good conduct. The course at the training-school should have special reference to the ration and the various modes in which it may be presented with the limited facilities of the camp-kitchen.

When the stay in camp permits it, a mess-hall in connection with the kitchen is advisable, to prevent contamination of the tents or huts with the débris of meals. Table furniture and kitchen utensils should be issued by the Supply Department, instead of being, as at present, an allowable drain on the company fund. The ration is the daily allowance of food, and the expenditure of any part of it for property purchases is a misapplication. Many company officers have a pride in the appointments of their mess-rooms, and the company fund is taxed to sustain it. Not that their men fare worse on this account than those who sit at a plainer table. On the contrary, companies which are well provided in this respect are usually well cared for in others; for it is rare that an interest in the appearance of the dining-hall fails to extend to the soldier's advantage over all the kitchen economy.

In the matter of food-supply, as in everything else in camp, much may be done by interested and intelligent officers to promote the comfort of their men. Regulations require a daily inspection on their part, but the letter of the law in this instance may readily be complied with and its spirit disregarded. Constant watch over the wastefulness of the more or less untutored cook is required, foresight in providing needful supplies, and care in the establishment of varied bills of fare to nullify the tendencies of the kitchen to fall into routinism. Inspection of the cooking arrangements by sanitary officers have little value where the company commander fails to exercise this supervision over the food-supply.

SECTION VII.

ON CAMP DISEASES.

Scurvy.

Scurvy merits special notice under the heading of this section, not alone on account of its importance as a camp disease, influencing even the healing of wounds in war-times, but to invite attention to the possibility of its unsuspected existence.

While the infrequent operation of its cause in civil life renders it unfamiliar to the body of the profession, the age in which we live, the very knowledge we possess of the means for its prevention, give a false security from which the inexperienced medical officer may only be aroused by unmistakable developments in individual cases. The insidious character of the disease favors the possibility of an unnoted invasion. Its pains in our camps have been treated as rheumatic, its prostration as malarial debility, and even its manifestations in the gums as a local affection induced by irritant chewing-tobacco, accumulations of tartar, carious stumps, and other unhealthy conditions.

But, instead of being an attendant solely on the unhygienic conditions of past centuries, long voyages, famine diets, or special cases of privation, it is shown by daily experience to pervade our so-called well-supplied camps; not in the aggravated form with which the continued operation of its cause characterized it in former times, yet of sufficient energy to markedly increase the virulence of other morbific agencies, and even to disable *per se*.

It was present in our armies during the late war, and its recognition was a surprise and shock to professional ideas preconceived from practice in civil life. It can be seen in our present Indian expeditions, and at many of our western posts, while at others, although it may not figure on the records, its presence is clearly appreciated by medical officers as a devitalizing influence.

Probably a closer investigation into the nature of many obscure complaints in civil life, with special reference to a possible scorbutic taint, would be of benefit to the patient in not a few instances. The writer, in practice among civilians in the neighborhood of military settlements—permanent *eastern* posts—has frequently recognized the mal-nutrition of scurvy as the basis of localized complaints.

As usually observed it is characterized by increasing debility with muscular pains in the loins or legs, or in the arms after their exercise. The skin is dry, cool, and rough, complexion muddy or livid, expression despondent, and gait sluggish. The tongue is flabby, and the gums slightly

tumid and prone to bleed under suction movement. Generally on examination a few petechial spots may be discovered on the legs; the patient complains of rheumatic pains; or, he does not know what is the matter with him, but feels "played out"—thinks he is going to have chills. He may complain of palpitations or of dyspnœa, and be worried in mind about his condition. Night-blindness, which is a suggestive symptom, may cause him to report. The local manifestation in the gums may rise to prominence without corresponding gravity in the general symptoms, which have then to be elicited from him. Perhaps, even, he may seek a remedy for small spreading ulcers on the neck, wrists, or other parts irritated by the friction of clothing. Diarrhœas are frequent.

Ecchymoses follow—and now the disease has assumed a greater gravity and lesser frequency as seen in our camps. They vary in size from a small bruise-mark on the calf to a blotch extending from the loin downward on a largely swollen limb. Ulceration takes place, and danger is augmented by internal effusions and hemorrhages.

This diseased condition has been satisfactorily connected with a deficient dietary. Its prevalence on shipboard, in camps and prisons, where the only constant unsanitary factor is the limitation of the food-supply to a certain issue, sufficiently proves this. Its cause was therefore sought among the articles constituting the ration. Salt meat, as forming the staple of such diets, had for long to bear the opprobrium of its production. But further observation showed its connection, not so much with the salted ration, as with that deprivation of fresh vegetables which is its usual accompaniment. This was found to hold as well in individual cases as in epidemic visitations.

The theory built on these observations regards certain of the constituents of fresh vegetables as furnishing material essential to the perfect nutrition of the tissues, the want of which induces the scorbutic deterioration. It is generally accepted that this material consists of the potash salts of the organic acids.

The objection to the theory is that it fails to explain *all* the cases which occur in practice or are recorded in history; cases where, with a so-called liberal supply, the disease has made its appearance when some unhygienic element was introduced, such as excessive fatigue, exposure to cold, diarrhœas from impure water, mouldy bread or tainted meat, overcrowding and dampness of quarters, etc.; or cases where, with the same food-supply, but with difference in some of the other sanitary requirements, two sections of a command have fared differently as regards exemption from scurvy.

To this the reply is that all circumstances causing waste of tissue, such as fatigues and disease drains upon the system, require increased ingestion of the special material supplied by the fresh vegetables (potash salts, Garrod), as well as of the regulation albuminoids and carbohydrates, and that the supply which would preserve the balance of health under one, might incline to scurvy under another set of circumstances.

But the principal objection lies in the fact that the disease has been

found to exist, to a limited extent it is true, but still to exist with free vegetable supplies.

Here it must be remembered that, as a free supply of food will not preserve the tissues at their normal standard in the event of any disorder of nutrition, so a free supply of vegetable salts does not exclude the possibility of scurvy in occasional cases. Perverted action from unknown, because unstudied, causes modifying digestion and assimilation, may render the supply valueless. As Immermann remarks:[1] "It is sufficient simply to mention the facts that the distance which the alimentary substance containing potassa has to travel in passing from the mouth to the tissue-elements is considerable, that it is readily turned aside from the direct course, and finally, that even when it has safely arrived at the cells it is not always necessarily absorbed into them."

Of the existence of such exceptional internal causes the writer is convinced by the recollection of the anxiety which his first case brought him. He, in 1860, made a trip on the whale-ship "Intrepid," of Peterhead, Scotland, the crew numbering eighty men. When about four weeks out one of the officers became affected with scurvy, but the inexperience of the surgeon failed to recognize the disease until ten days later, when large ecchymoses on the legs made it manifest. The condition of the men, who were, of course, subject to a more limited dietary, was examined with interest, but they were all in vigorous health. The patient was mentally much depressed on account of private financial matters, which a successful voyage was required to set to rights. A day or two afterward the "Intrepid" struck the sealing-grounds, and for five days her crew were over the ice among the young seals, snatching only an hour or two of repose at long intervals. The scorbutic patient became a new man as soon as the sealing flag was hoisted. He accompanied his command, worked as hard as any, and had just time to notice that his gums were consolidating and his spots fading, although no special change had been made in his diet; nor during the remainder of the eight months' voyage had he any return of the symptoms, while, in several instances among the men, the advance of the disease could be observed.

That mental depression may cause scurvy, by interference with the digestive processes, or perversion of nutrition, seems manifest by a consideration of the above case. This possibility must be borne in mind in permanent camps, where ennui, homesickness, and home troubles and anxieties are prone to unite with deficient supplies in inducing disease, and due efforts should be made to have healthful occupations and amusements as a sanitary measure. (See page 117 et seq.)

The influence of a change in the mental tone as strongly curative, not in the individual case as above, but in a command where the disease had a clearly defined origin in deficient supplies, is illustrated by the case of the California troops, who built Camp McDowell, Arizona, in 1865–'66. In the spring of the latter year the writer was ordered to proceed to that

[1] Ziemssen, Vol. XVII., p. 199, New York, 1878.

camp, then without medical attendance, which was sorely required. There were present four small companies, with forty men on sick report from scurvy, ten of whom were in hospital, the others in quarters. One man had died, two were severe cases with extensive ecchymoses, swelling, and ulceration; three or four more were largely mottled—all sufficiently serious to appall in the absence of vegetables.

The advent of a medical officer, without needful supplies, was no great matter for rejoicing; yet, as his presence was a proof that they had not been forgotten by the authorities, and as he brought news, and was an earnest of the arrival of the regular troops who were to relieve them, the tenor of their thoughts changed to hopefulness and home anticipations. Little could be done. The camp was absolutely destitute of supplies. All the native plants within reach which could be of use were gathered; but these, with a small supply of wine and bicarbonate of potassa, could not surely have brought about the steady and rapid improvement, had change in the *morale* not been coincident, else would scurvy have always been found the most tractable of diseases.

Whatever views may be held regarding the origin of scurvy in particular instances, it is certain that the mass of the cases of this disease depends on the want of a tissue-element supplied by the organic salts. When the disease appears in camp it may be accepted as evidence of the insufficiency of the ration. Were the energy and liberality which governments exhibit in combating scurvy after it threatens the ruin of an army to be distributed in a full and regular supply in the first instance, there would seldom be occasion for such spasmodic efforts. Scurvy would be banished from the list of camp diseases, or, failing this, opportunity would be given for accurately determining the influence of other possible causes.

Malarial and Aquamalarial Fevers.

In Section Second, malaria has been considered as connected with the decomposition going on in the vegetable matter of the soil, and all has been said concerning its genesis which is warranted by the facts when examined without aid from the etiological study of other diseases. We have an exhalation from the soil which, when absorbed into the system, sets in motion a series of phenomena, unique in what is called its periodicity. No doubt exists that intermittents and remittents, and certain adynamic and pernicious fevers with more or less tendency to remission, are results of the same miasm which we call malaria.

What the nature of the exhalation may be is unknown. Carbonic acid, carburetted and sulphuretted hydrogen gases, are found in the dangerous air, as also varied forms of microscopic life. Salisbury has endeavored to identify the disease-germ with certain species of palmellæ.[1] That the poison is a solid seems indicated by the immunity conferred by filtering the air through a respirator, handkerchief, or fine-meshed mos-

[1] American Journal Medical Sciences, January, 1866.

quito-netting, the particles appearing to be entangled on the filter. It is probable that the essential is a vegetable germ. Experiment throws no suspicion of malarial consequences on the inorganic gases, while, on the other hand, modern research has referred such troubles as autumnal catarrh and rhus-poisoning to air-borne spores, and cholera and typhoid fever to specific germs.

The prevalence of the gaseous or aëriform theory—the very name *malaria* stamping a gaseous form on first impressions—has tended to remove it in our nosology from its allied species, and with its periodicity of phenomena and non-contagiousness to elevate it into a separate genus, while all that has seemed inexplicable in its manifestations on the system has been thrown for cause upon the obscure domain of neurotic pathology.

When examined, however, in the light of our present belief, concerning the origin of miasmatic-contagious diseases in germs evolved originally how we know not, but probably from some less harmful progenitors by conditions favorable to their development—which germs are connected with decomposition when out of the body and with specific disease when in it—malaria ranges itself with these diseases, having dysentery as its connecting link to the more distinctly contagious members of the series.

The return of organic matter to simpler forms is accompanied by the development of such germs as find in it an appropriate nidus. This is seen in every fly-blown carcass; but the microscope shows in each morsel of decomposition a world of life, the study of which may be said only to have commenced. That certain germs exist and multiply in the decomposing vegetation of the soil, being connected with its decomposition and finding favorable conditions for their development therein, may be accepted as proved; and that when these find their way into the human system and there meet with vegetable tissues susceptible of the stage of decomposition which is native to them, they increase and multiply, developing according to circumstances the various grades of malarial disease, is consistent with the etiological reasoning of the present day. The malarial germ requires recognition as a source of specific disease as much as does the cholera or typhoid germ.

On a previous page (91) it has been advanced as a convenient hypothesis that malaria is an ultimate product of soil-fermentation, ready to take its place in the elaboration of superior vegetable life. In the language of current ideas, malaria is absorbed by the leaves. That the organic germ becomes attached or adherent to them may be accepted as consistent with its separation from the air by filtration or its fall with the snow; but what its further history may be remains for vegetable physiology to determine. These lower organisms may accumulate on the foliage, to be swept away by the first strong wind, or they may contribute to the perfection of the higher life with which they are in contact. The permanence conferred on germs by their vitality and the absence of malarial attributes to cut-branches or living vegetation during the day, would suggest that the malarial germs may have a history essentially connected with the living processes of the leaf.

In the human system the primary settlement of the germ is probably the digestive tract. In the allied diseases—dysentery, typhoid, cholera, and yellow fever—there appears little doubt that here the germs effect a lodgement, as local lesions attest the fact, and contagion is propagated by the excreta. Furthermore, it is only in the alimentary canal that the malarial germs can find that fermentable vegetable matter which is necessary to their development. And as this supply of vegetable matter, susceptible of a certain decomposition, is not continuous in the system, but intermittent, we have a hint as to the origin of one of the singularities of malarial disease. Having once effected a lodgement, the germs develop rapidly or lie dormant, according as their surroundings afford or deny them the conditions needful to their growth, giving rise to systemic disturbance in the one case—by which elimination is effected of themselves or some vicious product connected with them, as alcohol in saccharine matter with the yeast-plant—and in the other instance accounting for intermissions. The periodic returns, varying in each case with the conditions of the individual, continue until a cure has been effected by the antiseptic or germicidal action of quinine or other remedy, or until the system has adapted itself to the new condition. In the latter event there is no active manifestation of the disease until the equilibrium has been disturbed by some other influence, when the malarial complication becomes prominent, if only to give periodic exacerbation to the effects of the disturbing power.

An article on the hygiene of camps is not the proper field for following up the discussion of this question. Reference has been made to the germ theory of malaria solely on account of its bearing on the propagation of the disease by means of water. But, as the non-contagious character of malarial maladies has been instanced as constituting a generic difference between them and the contagious miasms of cholera and typhoid, a word may be said in explanation. Malarial disease is called purely miasmatic, as always originating in causes generated outside of the system, and never propagated by germs of internal development. But we have here no objection to the application of the germ theory. Contagion is a question of degree simply, the degree depending on the vital activity of the germ. This activity is greatest in yellow fever and cholera, least in dysentery and malaria. Yet, even in the last, cases are recorded of contagion from individuals. These have to be carefully scrutinized to exclude possibility of infection in the ordinary way, by air, and especially by water. But as they are presented by observers biassed, as we all are, in favor of non-contagion, they deserve a fair place on the record as among the anomalies which the correct theory of malaria will of necessity explain.

In the section on the water-supply, the writer has indicated the probability of the introduction of malaria into the system by its means. Malaria is undoubtedly the cause of mountain fever, and equally certain is it that this malaria accompanies the vegetable matters washed down from the atmosphere by the rain and snowfall. We have no hesitation in acknowl-

edging the presence of the poison in air when exposure is followed by specific disease. We would have as little, but for our preconceived notions, in acknowledging its presence in water when specific disease follows its ingestion. But it is difficult to allow the presence of an aëriform or gaseous poison in the falling snow-flakes. A permanence of the poison would be implied under certain conditions of the atmosphere, notably the presence of oxygen, moisture, and electric agency, which is wholly at variance with our experience of organic exhalations. In organic matter of such minute division, exposed to such vicissitudes and powerful destroyers, there must be the resistance of a vital force to account for the viability or permanence which this poison undoubtedly possesses. It must exist as a living germ.

Thus, the theory of a *contagium vivum*, while explaining the presence of malaria of full potency in water-supplies derived directly from aërial precipitation, is itself sustained by the fact of that presence.

The camp-fevers of this country are malarial, the germ being either air-borne (*malarial*) or water-carried (*aquamalarial*). In the former case we have intermittents and remittents, the grades of intensity varying with the amount of exposure, or, otherwise to express it, with the rapidity of the germ-colonization and with the internal condition of the individual. In the latter the disease is perhaps invariably remittent, frequently of an adynamic type, approaching a fatal issue by great prostration, emaciation, dysenteric attacks, muttering delirium, and coma-vigil.

These aquamalarial fevers are best studied in the mountain regions and non-malarious mesas, prairies, and table-lands of the West, where they are uncomplicated by malarial air-borne fever. On the records they appear as malarial remittents, but the obscurity heretofore enveloping their origin, together with their manifest adynamic tendencies, has led to the assumption, in many dangerous cases, of a possible typhoid germ, and the disease has been recorded ambiguously as typho-malarial, or definitely as typhoid fever. It will readily be conceived that a strong effort is required on the part of the physician in attendance to record a death as from malarial remittent in a non-malarious country, while the adynamic symptoms insinuate the possible presence of specific typhoid.

Descending from the higher grounds to lower levels, or lower latitudes, malarial and aquamalarial germs combine to sum the total of our camp-fevers. The aquamalarial breed have not been distinguished from the other in these localities. They are swamped, as it were, in the general flood of malaria which inundates the land and prostrates the residents; but that they exist is not to be doubted, for it cannot be supposed that exposure to atmospheric germs carries immunity from the evil effects of the same organisms when introduced in the water-supply.

As protective against malarial disease the dry site and dry vicinity have been sufficiently insisted on, and if those favorable conditions cannot be obtained, a consideration of the known facts concerning the history of the malarial germ suggests the methods of limiting it in its rôle of disease-producer. As these have been adverted to in the course of the fore-

going pages, and moreover, as they are of general interest, and not a specialty of the camp hygienist, further reference to them is deemed needless.

Typhoid.

In more populated districts the specific germ of typhoid may add its train of symptoms to the list of camp-fevers. It is a disease which has, without doubt, invaded our camps in many instances; but that it figured during the late war—simple or masked by malarial concomitants—as largely as we are called upon to believe by Dr. Woodward,[1] has been shown by the writer [2] to be exceedingly doubtful.

Concerning its origin, we find a tendency on the part of the systematic writers of the day to insist on propagation in all cases from germs grown in the human system during an attack of the disease. Animal decomposition, they hold, is in constant progress in the vicinity of our communities, but without the specific germ from a previous case of fever no focus of typhoid infection can be formed.

But the profession is slow to accept this doctrine, as it runs counter to much individual experience in country districts. Moreover, the germ theory does not involve such exclusiveness, but points to the possibility of a *de novo* origin. In the past, certain microscopic organisms connected with the fermentation of animal matter uprose from the soil, constituting a miasm, and, when transplanted into the human system, finding favorable conditions for their development therein, gave rise to typhoid fever. Having thus originated, the disease is propagated by germs grown in the infected systems of a continuous series of individuals. But the reasoning which would exclude a recurrence of this origination in the present is not clear. What has happened may again occur. Objection to a present miasmatic origin would bespeak a parasitic or internal status to the germ of the disease, by virtue of transmission through numberless individuals of the human race, during which it evolved its present powers for evil. But there is no ground for such a supposition. On the contrary, the origin of dysentery in soil miasma, and its subsequent propagation by germs of internal growth, strengthens the opposite view.

Under the circumstances the suspicion of *de novo* cases of typhoid should lead the sanitarian to accept the possibility of such an origin, the better to guard against its occurrence in his camps.

In the event of its invasion, removal of the cases as they occur is required, and thorough disinfection of the sinks; while, if the disease threatens to become endemic, change of location is indicated.

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[1] Camp Diseases of the United States Army, Philadelphia, 1863; and in the pamphlet: Typho-malarial Fever; Is it a Special Type of Fever? Being remarks introductory to the discussion of the question in the Section of Medicine, International Medical Congress, Philadelphia, 1876.

[2] On Mountain Fever and Malarious Waters, Am. Jour. Med. Sciences, Jan., 1878.

Diarrhœa.

Diarrhœa is usually the most frequent entry on the medical registers of camp, inasmuch as all unsanitary conditions of camp-life are prone to determine its occurrence.

When it occurs we recognize an effort of nature to eliminate some morbific matter from the system. The deleterious substance may be a local irritant in the alimentary canal, in which case the disease is trivial, unless the operation of the cause be sufficiently powerful or prolonged to induce inflammatory action. The *origo mali* may be a miasma, such as the malarial—some organic poison introduced from without, or accumulated within by suppressed function of other emunctories, and in these cases also the presence of enteritis gives greater seriousness to the disease. Lastly the pathological or depraved condition of the blood in certain cachectic states may be regarded as furnishing morbid material, to eliminate which the system makes continuous but futile efforts, until enteric changes take place and the strength fails, as in the graver cases of chronic diarrhœa.

A reference to the causes which mostly prevail in camps is all that is needful to indicate the sanitary measures for the suppression of diarrhœal proclivities. As in civil life, improper food and improperly cooked food furnish most of the causes of local irritation. Insufficiently masticated food might be mentioned, but the cases to which it gives rise are sporadic; yet even here the hard bread and beans of the camp ration tend to enlarge its field of operation.

The improper foods include all articles which have suffered damage from imperfect preservation, and meat which while on the hoof has been over-driven, badly fed, or affected with disease, or which has been kept too long in the slaughter-house after killing, or in the haversack after issue or cooking. To these must be added an ignorant indulgence in many articles in themselves either proper or improper, into which troops are impelled, when opportunity offers, by the sameness of their diet under ordinary circumstances.

Water furnishes the diarrhœal cause in many instances, either from purgative or irritant inorganic salts, or from animal or vegetable contamination.

Air carries the malarial germ into the system as a prolific source of camp diarrhœas; or the originating miasm may come from unpoliced sinks or unburied carcasses. The last is rarely seen as a cause except in battle-camps. The writer had occasion to appreciate the influence of the putrescent odor on the Chancellorsville battle-ground, where he was for ten days on duty, under flag of truce, with the wounded prisoners of the Second Army Corps. The sultry air was rank with the pestilent effluvium from the slain horses of a battery which had been engaged near the site of the extemporized hospital, and scarcely a man was free from diarrhœa. It is true other causes were at work—causes connected with food and exposure and the presence of suppurating and gangrenous wounds; but among

other aggregations of wounded on the same field, exposed to similar influences, less the air-taint from the dead animals, the diarrhœa was less general.

But the morbid matter requiring elimination may be self-generated by the command in crowded or unventilated tents or huts.

Again, it may be self-generated within the individual and thrown for excretion on the alimentary lining on account of suppressed skin-transpiration; hence, any influence which interferes with the normal action of the skin may be a source of camp diarrhœa. It is not supposed that fatigue is of itself a cause; but that it predisposes is undoubted, partly by lessening the resisting powers of the system and in part by the increased waste which has to be thrown off. The functional activity of the skin is liable to check by rapid cooling after cessation of the exercise, as when the men throw themselves on the ground to rest, and the waste products are carried to the mucous membrane for discharge, constituting a congestive diarrhœa. The same may happen from climatic influences, as sudden lowering of temperature; and in the category of causes, as failing to protect against this source of the disease, insufficiency of clothing and tent-covering must be enumerated.

Lastly, the influence of the scorbutic taint has to be remembered as in itself exciting, or if not, so strongly predisposing that local irritants which would be unfelt in healthier conditions give rise to dangerous and often fatal diarrhœas.

Dysentery.

While diarrhœa owns a multiplicity of causes, the tendency of medical observation is to confine dysentery to the operation of one—a miasmatic germ connected with animal or vegetable decomposition in the soil. The prevalence of the disease in malarious districts points to an analogous origin in endemic miasm, and its frequent attendance on malarial remittents resulting not only from aërial poison but from water-impregnation, indicates similarity of habit.

The specific germ settles in the lower bowel, where matter favorable to its development is accumulated, and by its presence determines congestive and inflammatory changes in the walls.

But, as local irritants may induce a similar disturbance of function and nutrition in the intestine, the occurrence of sporadic cases need not imply the presence of a specific germ. They may be owing, by a transference in the locality of action, to the varied agencies which conduce to diarrhœa, and it is probable that sanitary measures preventive of the latter will exclude the former disease. Sporadic cases, however, barely come within the scope of the present writing. The disease, when it merits the title of camp dysentery, is epidemic.

Many examples of dysentery apparently from miasmatic influences are given by medical authorities; but the writer does not require to go outside of his own army experience for an illustrative outbreak—one which ex-

cludes many of the alleged causes of dysentery, and which points definitely to a soil-poison. In 1866 the commanding officer of Camp McDowell, Arizona Territory, was directed to cultivate a piece of bottom-land, about one hundred and fifty acres, in the neighborhood of camp. A vegetable supply for the men and forage for the horses were to be raised. This was intended as a sanitary precaution against scurvy, which had existed among the recently relieved California troops. (See page 144.) The ground required much preparation—removal of brushwood, extraction of stumps and roots, and breaking up of sods—before it was rendered fit for cultivation, and a deep ditch four miles long had to be dug to bring down water for its irrigation. All this work was performed by details from the men of the three companies constituting the garrison. During its progress dysentery broke out, and 6 deaths in 20 cases, with 56 cases of contemporaneous diarrhœa,[1] cast a gloom over the little community, making many anxious for personal safety. It was observed that only those suffered who had been employed on the newly-broken ground. The farm was turned over to Mexican employees of the Quartermaster's Department, and the dysentery subsided. No such epidemic had occurred at the post previous to the inauguration of this agricultural work, although the garrison had been subject to much hard service, implying fatigue, exposure to climate, and deprivation of food. Even scurvy had been present to a marked extent in the former volunteer garrison, without dysenteric outbreak. And the sinks, quarters, and general police of the camp, when the visitation took place, were in as satisfactory condition as at any time in their previous history. Nor has such an epidemic occurred at the post since that time.

Allowing the miasmatic origin of camp dysentery, the inadvisability of disturbing the soil, especially in malarious localities, is strongly suggested. Natives of the country should be employed where such work is imperative, and the troops be guarded against exposure. Even the site of quarters must be carefully treated in view of dysenteric possibilities. (See page 109.)

In active service no sanitary precaution can guard, in every instance, against this disease. Field-works have to be thrown up and bomb-proofs to be dug out and occupied. Military necessity calls here for exposure to disease as it frequently calls for exposure to gunshot wounds. Both have to be accepted as war-risks; or the risk of the one may be viewed as the price paid for protection against the certainty of the other.

As with malarial disease, so with dysentery: its spread is seldom referred to germs grown within the system and thrown out with the alimentary excreta. But there are enough of cases on record to show the probability of such a mode of propagation. To establish the fact requires careful observation, as it can only occur where the disease is very prevalent, and here it is manifestly difficult to separate the effects of the primary from those of the humanized miasm.

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[1] The writer, having lost his note-book containing the particulars of the outbreak, is indebted to Dr. J. J. Woodward, U.S.A., for the figures from the official records.

But with dysentery epidemic, or threatening to become so, it will be allowed that all congestions of the intestinal mucous membrane assume a graver significance. They may not predispose to the specific attack, but, should it occur, they must certainly add to its virulence. Their causes must therefore be carefully excluded; and since foul odors, as has been seen in speaking of diarrhœa, may determine to the threatened membrane, disinfection of sinks and all discharges is suggested as a precautionary measure, irrespective of theoretical considerations. In fact, the sinks should be filled up and the camp-site abandoned, if contagion by a humanized germ is suspected.

The possibility of the introduction of the germ into the system by the water-supply must be held in view. This might take place from sink-contamination, or, as was probably the case in some instances at McDowell, from the use of water flowing through a newly-cut acequia.

Cholera and Yellow Fever.

Cholera and yellow fever can scarcely be arraigned with propriety under the heading of this section. Their miasms are too widespread in their operation for discussion in an article on camp hygiene. But, as soldiers are as liable to their attacks as are more settled communities, a few words concerning them may not be out of place, especially as the discipline and mobility which pertain to camps have a bearing on preventive measures.

In both of these diseases observation and research appear to recognize specific germs as the origin and means of propagation—germs which require out of the body a high summer temperature for their active proliferation and dissemination as epidemic disease agencies.

There seems no room for doubt that these diseases spread from their habitat by colonization, the germs being carried by the person of an infected traveller, or by some material which has come from an infected district. Quarantine and disinfection, as preventing the introduction of the germs, are thus our best safeguards.

But the mobility of the army-camp gives it a better protection than this, when military reasons do not interfere with the temporary abandonment of the camp-site. During the past disastrous summer (1878) in our Southern States, the federal troops fell back before the advance of the disease,[1] and a repetition of the experiences of the 1867 epidemic[2] was prevented. The deaths among the nominally acclimated men who were left in garrison to guard property showed what fate would have befallen the troops had this movement not been executed.

If, however, such a retreat is incompatible with strategic requirements, a line of sentinels should be posted around the camp to cut off all unauthorized communication. No person should be admitted within the lines with-

[1] See Annual Report of the Surgeon-General U. S. Army for 1878.

[2] Cir. No. 1, S.-G.O., Washington, June 10, 1878: Report on Epidemic Cholera and Yellow Fever in the U. S. Army during 1867.

out undergoing quarantine examination, no baggage or supplies without being disinfected or passed by the quarantine officer.

The water-supply, if it comes from without, or if a suspicion of contamination from without can be harbored against it, must be boiled before being used, even for police purposes; while any pure supply should be placed under guard for use as drinking-water. Should it be impossible to procure such supply by other means, it ought to be distilled. The writer has no confidence in purification by permanganate, for the malarial germ, as we have seen, withstands oxidizing influences, and we cannot suppose less of vital resistance in the germs of cholera and yellow fever.

Police regulations should be scrupulously carried out. The troops should be protected from all anti-hygienic influences. There should be no unnecessary exposure to sun, rain, or night-air, and no drills or fatigue duties other than to furnish occupation and needful exercise. When the military conditions permit, the camp should be viewed as engaged in an active campaign against an insidious and impalpable enemy, and the attention of every officer devoted to superintending the conduct of his men with special reference to this view.

If, in spite of all precautions, the disease effect a lodgement, no change should be made in the quarantine and other regulations. Fresh importation of germs is to be as sedulously guarded against as if the camp were yet free from infection. Cases should be removed to hospital as soon as manifest, disinfectants[1] used in the sinks, and the bedding and clothing of the infected soldiers removed to the quarantine station for disinfection. In the hospital all precautions which our knowledge may suggest are of course in order against the spread of the disease-germs.

But if, despite such sanitary measures, the disease shows a tendency to epidemic prevalence, the troops should move camp to a new site, leaving their sick behind, keeping up their quarantine on the new ground, and sending such cases as may occur back to the hospital on the old site.

SECTION VIII

FROM CAMP TO CAMP.

The day's march is set down in the United States Infantry Tactics[2] as from 15 to 20 miles, and by medical writers as from 10 to 20 miles—the former distance being considered an easy, the latter a long march. Good walkers in civil life may view these distances as trifling when regarded as

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[1] The writer is aware that their use was considered valueless in the recent yellow fever visitation. Sulphur will kill the itch parasite, but it will not cure a patient whose skin, clothes, bedding, and all surroundings are infested, even if applied to every point of the integument where pustulation is manifest.

[2] General Upton's, approved by the War Department in 1867.

a day's work. But the measure of distance does not represent equivalent expenditures of force in the case of the civilian pedestrian and in that of the soldier as a unit in a moving army.

In the first place, the load which the soldier carries must be taken into consideration. This consists of rifle, bayonet, cartridge-box or belt with forty rounds of ammunition, haversack with three days' rations, plate, spoon and tin cup, canteen with the day's water-supply, a spare pair of drawers and socks, shirt, towel, soap, comb, overcoat, blanket, shelter-tent canvas, and perhaps poncho—the whole weighing from forty to forty-five pounds avoirdupois. Various knapsacks have been suggested as a convenience in carrying the spare clothing, blanket, etc., but as they compress the chest or excoriate the arm-pits, their use has been generally abandoned by our troops, who sling their impedimenta from each shoulder to the opposite hip, the canteen and cartridge-box offsetting the haversack, and the roll of blankets on one shoulder balancing the rifle on the other.

Again, the soldier's miles are either miles of dust or mud, for the soil which does not throw up dust under the tread of an army is usually so damp as to break down under the leading regiments and form a quagmire for the others to labor through. The fatigue and discomfort of a march under either of these conditions must be experienced to be duly appreciated.

Further, the soldier has a fixed position in the moving ranks which he cannot alter, even by an accidental stumble, without incommoding those of the command in his rear and being incommoded by them. So, also, the regiment of which he forms a part has a fixed position with regard to others. Any delay in the advance, by obstacles on the road, is transmitted along the column, and, the obstacle having been overcome, rear regiments must accelerate their pace to recover their lost distance, or leading regiments move slowly or halt to allow the others to come up. During such delays the soldier cannot rest, as he would disarrange his pack, and the column might move forward at any moment. Thus, the time spent in waiting, leaning on the musket, and wondering what is the matter ahead, is as much, perhaps more, of a drain on his energies as the same time spent in an advance, every step of which is believed to bring him nearer camp. In fact, the march must be measured not by miles, but by the number of hours from the breaking-up of camp in one position to its establishment in the other.

Lastly, the march of the soldier does not constitute his day's work, but is labor over and above the usual routine duties of camp and fatigues of war emergencies.

On marches an early start is usually desirable to afford the men time enough on the new ground to make themselves comfortable before nightfall; especially is this necessary in rainy weather or inclement seasons. Breakfast is taken before starting, lunch at a mid-march halt, and dinner in the evening after arrival.

When no unlooked for obstacles stand in the way of the advance the ground passed over may be computed at 2.4 miles per hour. The quick-

step has 110 paces per minute, covering 2.9 miles an hour; but the rests recommended, and usually necessary to bring the column to its destination in an efficient state, reduce the average hourly distance as above. At the end of the first half-hour a rest of fifteen minutes enables the men to rearrange their burdens with the experience they have gained during the short effort. After this a rest of ten minutes at the end of every hour is sufficient to bring the column to camp without stragglers, unless the march exceeds ten miles, when one of the rests is lengthened to half an hour for luncheon. A march of 18 miles thus requires seven and a half hours for its accomplishment.

If the marches exceed 18 miles a rest of one whole day will be the sooner required on the route. After marching 25 or 30 miles in one day, a rest is usually needful on the day following. Forced marches are spasmodic efforts which gain nothing on a long journey, for the rest which is necessary after them reduces the daily average.

In the hot season, in our Southern Territories, the march is accomplished, if possible, before midday. When the regular troops took possession of the Indian country after the civil war, night marching was occasionally attempted, but was given up in favor of an early morning start. Night marches are only made now in passing long distances from water to water. Time is lost rather than gained by them, as the troops must rest on the day before, as well as the day after, the effort. The writer accompanied a detachment of the First Cavalry on a scouting expedition, where an unobserved entry into the Apache country was attempted by marching during the night and lying *perdu* in hollows and cañons during the day. After four or five days the men showed signs of breaking down, and the attempt was not renewed. In this case the night march had less to do with the result than the wearisomeness of the day and inability to sleep in the stiflingly hot atmosphere of the resting-places.

With favorable weather in non-malarious countries the sick-list on a march may be expected to be less than the camp-list of the same command. During the first few days, before the troops are inured to the journey, some may become foot-sore and excoriated. To prevent this, company officers should instruct their men on the care of the person, insisting especially on bathing the feet and changing and washing socks on every available opportunity.

Exposures are necessarily incident to a march; but, as an offset to this, the resisting powers of the system are, within limits, increased by their exercise. It is often surprising how little injury a marching command will receive from most inclement weather. The writer was out in the Nez Percés war in September, 1877, with the Fifth Cavalry, 800 strong, and not a man was reported sick, although the command passed three successive nights in wet clothes, and was exposed during the expedition to all kinds of weather, from the sultriness of the plains to the snowstorms of the mountains.

Extremes of temperature are dangerous, as giving rise directly to heat-exhaustion and sunstroke in the one case, and frost-bite and general de-

vitalization in the other. But, speaking generally, warm weather is productive of greater loss of efficiency than cold. The latter can be guarded against by full diet and warm clothing, while the exercise itself is protective, and, reciprocally, the cold is preventive of danger from the exercise.

In warm weather the extra heat developed within the system by the march must be dissipated, else a superheating of the blood will interfere with its normal tissue relations and manifest itself as sunstroke. Nature accomplishes this dissipation by means of the cutaneous and pulmonary transpiration, and requires for the perfection of the operation free expansion for the lungs, light covering for the body surface, and a water-supply furnished as required by the progress of the transudation. Were these requirements in all cases fulfilled, sunstroke would be rendered an unfrequent accident of the march, by restricting its occurrence to cases where some abnormal blood condition interferes with transudation, or where atmospheric saturation prevents surface evaporation.

Some medical observers have noted the prevalence of sunstroke in a moist and warm air, others in a hot and dry atmosphere. The difference is immaterial; in both cases the blood is thrown into an altered condition by inadequacy in the refrigerating process. A tendency to capillary stasis is induced, the heart labors to overcome the obstruction, and failing, gives us the syncopic or cardiac variety; or, the nervous system, resenting the increasing abnormity of the circulation, develops convulsions and coma as the cerebro-spinal variety of the disease.

On the march, the most frequent cause of sunstroke is a failure of the water-supply, aided by the chest-pressure of the various belts and straps by which the soldier's load is suspended from his person. This was the case in the summer marches of the Army of the Potomac.[1] If the water in the canteens lasted until the next opportunity of refilling them, so that ingestion and transudation were equalized, the men pushed along, faint from fatigue perhaps, but in no danger from sunstroke. If, on the other hand, the supply failed and the skin became dry, danger from sunstroke was imminent.

Whether the symptoms of the attack depend on loss of water from the blood beyond the limit consistent with functional activities, or on the increased heat consequent on suppression of evaporation, is an open question, but of little interest in this place, as the preventive measure on both theories is an insured continuance of the water-supply, and the immediate means of restoration in individual cases—water affusions for skin absorption and cooling, and water by the mouth as soon as the patient can swallow.

During a service of four years in Arizona, with a climate almost as hot as that of India, the writer saw sunstroke on but one occasion. Yet most of his service was in the field with commands of from 50 to 500 men, and long marches were made, often on scant allowance of water. This expe-

[1] Sunstroke as it occurred in the Army of the Potomac: Ch. Smart, U.S.A., Am. Jour. Med. Sciences, April, 1865.

rience he attributes to a care that the men should always have some water available. In the early part of the march the canteen was to be used as if no more could be had until arrival in camp. If, fortunately, a supply presented on the line of march, it was used freely, but the canteens, when refilled, were again used with the same caution.

In the one instance where sunstroke disabled the command, this rule was not followed.

On the 3d and 4th of July, 1867, an escort party of twenty-five men of the First U. S. Cavalry passed over the stretch of dry sandy country from the Sink of the Hassayampa to the Salinas River, a distance of over forty miles. They used up the water in their canteens on the evening of the 3d, expecting to find a fresh supply in a river-bed which they would pass shortly after midnight. A couple of hours were spent in digging in likely spots of the dry channel, but no water was found, and the party had to resume its march with empty canteens. Three hours after sunrise the men began to suffer. Afterwards, several had to be dismounted and placed under the shade of mesquite trees to await the return of six men who had been dispatched in advance to the Salinas with the canteens. These returned by mid-day. Two of the exhausted men had in the meantime become insensible and convulsed. Two others had wandered from the poor shade in which they had been left, and some difficulty was experienced in recovering them. Those who remained quietly until the water arrived were speedily able to mount their horses and aid in looking for their missing comrades. All were brought to camp on the river by 2 P.M., twenty-two hours after the commencement of the march. Convulsions recurred and delirium continued in the two worst cases for twelve hours after reaching the river, but perfect recovery ensued. These men had passed the same stretch of country, without injury, in the reverse direction, only a couple of weeks before. Failure of the water-supply was undoubtedly the occasion of their break-down on this march.

The cavalry soldier is not so liable to dangerous attacks as the infantryman. During the march he is less called upon for violent exertion, and there is consequently less development of heat. The advance to the sunstruck condition is thus more gradual.

The foot-soldier often struggles along with the perspiration drying on his skin, mucus sticking in his respiratory tubes, and increasing stasis in the lungs, until he falls syncopic or in convulsions. This can only be prevented by having the water-supply of the system unfailing, and giving the men certain intervals of rest, during which they may relieve themselves of the pressure of their loads and re-arrange them as experience may suggest, while the circulatory excitement and heat-development become moderated. If the allowance of water is scanty, it must, nevertheless, be used at regular intervals, but economically, lest it give out. There is manifestly less danger of a fulminant stroke with a stinted but steady supply than with full allowance for a given time followed by a period of enforced abstinence. On the other hand, if the supply is liberal, it may be indulged in freely, and with advantage, when the skin is acting well.

Its temperature is never such, on a hot day's march, as to chill the stomach and shock the system.

Probably the most noteworthy march recently reported in our western service is that of Captain Nolan, Tenth Cavalry, who with forty men, in July, 1877, was on the Staked Plains for eighty-six hours without water.[1] The men drank the blood of horses killed on account of exhaustion. Three cases of sunstroke are reported by the time the command completed its fifty-fifth mile. Altogether the loss was four men, four mules, and twenty-five horses.

The march requires special attention to the condition of the person. The infantry soldier should groom himself as carefully, after the toils of the day, as the cavalryman his horse. But, after what has been said on this subject in Section Fourth (see page 116), further reference is deemed unnecessary.

SECTION IX.

ON THE ORGANIZATION OF THE HOSPITALS OF CAMP.

What has been said heretofore in this paper has had reference mainly to the exclusion of disease, but that it has a bearing also on the result of wounds is obvious when consideration is given to the influence of the scorbutic taint, malarial prostration, diarrhœal tendencies, etc., on the healing process.

But, if we conceive the exclusion of all morbific agencies on account of the inefficiency of which they are the direct cause, something remains to be said concerning the sanitation of the wounded.

It requires no reading of the medical history of armies or of surgical reports from the battle-field to show that, whatever hygienic measures are taken in camp to preserve the health of the troops, the mortality among the sick and wounded will in great part depend on the provision made for their care. If an epidemic settles on the camp or a battle is fought and the medical officers prove insufficient, or inefficient either of themselves or by want of co-operation on the part of Supply and Transportation Departments, the result to the sufferers is alike disastrous.

A camp-hospital hygiene thus comes forward for discussion, which, in in its largest sense, may be said to consist of: 1st, a sufficient medical force; 2d, the endowment of that force with sufficient powers—that is, rank and command, to permit it to carry out its views for the amelioration of the condition of the disabled; 3d, an efficient organization of the force to enable it to work to the best advantage.

The treatment of the sick and wounded soldier, as a humanitarian

[1] See copy of Official Report in Army and Navy Journal, September 15, 1877.

question, has so much interest alike to the profession and the public, as to bear a review from the dawn of history to the latest advance. Especially is the medical officer of the U. S. Army qualified to speak on such a subject, as, in our present Indian wars, he can not only appreciate the termini by observing aboriginal practices, himself being supplied by a progressive administration with all that modern science can suggest, but can also realize many of the intermediary stages, as the exigencies of his campaign force him to give up more and more of the advantages of civilization, until at last he has to treat his sick and wounded under the shade of a tree, and copy the travois of the savage enemy for their transportation.[1]

But as the object of this paper is to show, not what has been, but what ought to be, reference will only be made to the results of recent experiences.

With regard to the first requirement of field-hospital hygiene, it will seldom happen that the sick and wounded will suffer for want of a sufficiency of medical men. Each detachment on Indian service is provided, according to its size, with one or more qualified officers; and in the event of a great war, volunteer medical aid would fill the positions rendered necessary by the increased number of troops and of field and reserve military hospitals.

The United States obtained its regimental organization from the British military system, and, as a part of it, the appointment to the regiment of a surgeon and one or two assistants. But, as our troops had to be scattered by companies in the sea-coast fortifications, and at innumerable points in the interior as protection to the advance of the settlers, the regimental organization soon came to exist only on paper, while the real unit for discipline was the company, and for practical military government the post. The post-commander became, as it were, the equivalent of the regimental in all matters not pertaining to the records of the officially recognized, but practically latent regimental organization. Under these circumstances the medical force became detached from the broken-up regiments and formed into a corps of post-surgeons, assignable to duty by the chief of their corps at this post or with that detachment. This was the status of the medical department of our army at the outbreak of the civil war.

But the aggregation of troops which was then necessitated led to the resumption of the regiment as the practical unit of organization, and a surgeon and assistants were enrolled with every new command. Meanwhile, such of the former post-surgeons as were not on regimental duty with the now concentrated regular command were assigned to administrative and executive duties in connection with medical affairs in the field or with the general hospitals established throughout the country. These were subsequently strengthened by the formation of a staff corps of volunteer surgeons, many of whom had already seen service with regiments.

[1] Circular No. 9, Surgeon-General's Office, 1877: On the Transport of Sick and Wounded, by Geo. A. Otis, Asst. Surgeon, U.S.A.

There were thus in the army two sets of medical officers: the one, numerically small, occupying staff positions, and having, from their enlarged sphere of duty and previous military experience, tendencies to centralization of management and co-operative execution; and the other, the large force of regimental surgeons, whose tendencies were to individual responsibility, each as the head of his own hospital department.

The commissions of the latter identifying the individual with a given regiment, among the personnel of which he had probably a large *ante bellum* acquaintance, and above all the regulation recognition of regimental and of none other except general hospitals, were the causes which prevented a more rapid development of the consolidated hospital system.

The Regulations established a regimental hospital and made provision for its tents, transportation, and supplies. Its tents were pitched on the left and rear of the regimental camping-ground. Where the regiment constitutes an independent command, this hospital arrangement is as perfect as it can be made. The surgeon is medical director and sanitary inspector by virtue of his position on the staff of the commander; he is also regimental surgeon of the one regiment in the command; is surgeon in charge of his hospital, and assigns his assistants—one to the care of the records, and the other, to that of the bedside economy. On a march the hospital-wagons are necessarily in the neighborhood of the troops, and on hand should an engagement occur.

But when the regiment is one of a hundred such within the lines of the same camp, the regimental system of hospital organization calls for an unnecessary multiplicity of institutions. This involves reduplication of material, entailing expense and absorbing transportation, both of which would be better applied to other purposes. It gives the hospitals compulsory sites, each having to accept the ground covered by the regimental battle-front. It destroys the value of the hospital fund of the army by splitting it up into many independent and petty sums, so that cases in one hospital may have to depend for delicacies on private purchases or on contributions from the table of medical or company officers, while a neighboring institution may have funds on hand without necessity for their employment. Lastly, instead of conferring on the sick or wounded man the benefit of the best professional advice which the camp affords, it confines him for treatment within the lines of his regiment.

Notwithstanding these disadvantages, a predilection for this system was for a long time shown in every standing camp. This was chiefly owing to the status and occupation it afforded the regimental medical staff. But it had part origin in the desire of commanding officers to preserve the strength of their commands by retaining their sick until recovery took place—a man sent to general hospital being regarded as lost indefinitely. In part also the esteem of the small hospital depended on the desire of the sick man, if he could not be sent to his home, to remain with his comrades rather than go among strangers for treatment.

But when a larger experience demonstrated to medical officers the advantages of a higher organization—when regimental commanders appre-

ciated that the consolidated field-hospitals returned the sick on recovery as readily as their local institutions—and when the men realized that they were as much at home within the lines of their brigade or division as when in regimental camp—the small hospitals came to be regarded as unnecessary, and were ultimately disused.

But it was on active service that the inadequacy of the regimental hospital system was first manifested. Men falling sick on a march were picked up by the ambulances,[1] transported to camp, and unloaded on the ground which would become the site of the regimental hospital as soon as the baggage-wagons arrived. The light ambulances, following in the immediate rear of the marching division, usually delivered their sick and moved off to their own camping-ground long before the supply-train came up. The patients were thus for a certain interval left without shelter. Seriously sick men were provided for by the hospital attendants or the care of their comrades, on some occasions hours before the hospital could be opened for their reception. During the march the sick were in reality aggregated into a division ambulant hospital, with a surgeon in charge, and assistants on special detail to receive the patients provided with passes from the regimental officers, and to treat such as required immediate attention. But the fact was not recognized, the ambulances being regarded only as means of conveying the sick from the regimental hospital in one camp to the same institution in another. This ambulant hospital was therefore carefully broken up every evening by the distribution of its patients among the various camps; and next morning the labor of collecting them was a necessary preliminary to its re-formation. Sometimes a sick man, much exhausted by the jolting of his transit over rough roads, would beg to remain at the ambulance camp for the night rather than be carried half a mile farther to his proper hospital. Again, the baggage-wagons being far in the rear and the weather stormy, all serious cases might be retained by order in the ambulances as affording a certain shelter, thus constituting a rudimentary division ambulant hospital by night as well as by day. In looking back, it appears surprising that the suggestions of every day's experience were not sooner worked out into a regularly organized system.

On the battle-field, as on the march, the regimental hospitals were found inefficient, although here the Regulations permitted liberties to be taken with them, aggregating but not consolidating them into depôts which continued during the emergency. The medical director was authorized, after consultation with the quartermaster, to send certain of his officers to the front with the ambulance wagons to render such immediate aid as might be required by the wounded. The others he directed to fall

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[1] In this country we apply the word *ambulance* to the light four-wheeled, two-horse wagon, which carries the sick on a march, or the wounded from the front to the field division hospitals.

For recent improvements in the wagon, see Report of a Board of Officers to decide upon a Pattern of Ambulance Wagon for Army Use, Washington Government Printing Office, 1878.

back to certain sheltered points in the rear, where they treated the cases as they were brought in from the field.

But these depôts lacked system and co-operation. They were simply a collection of regimental operating-tables, regimental supplies, and regimental officers; and although humanity, and we might say professional instinct, freely proffered co-operation of service, a surgeon would hesitate to place his supplies at the disposition of another command, if there seemed little likelihood of replenishing them before his own regiment became engaged. However, as in the ambulant hospital of the march, there was here the germ of consolidation which developed ultimately into as perfect a system of field-hospital organization as appears in military history.

It may seem strange that, while so much system existed in all departments of the army, it should be lacking in such an important matter as the care of the wounded and sick. Regiments were organized into brigades and the brigade handled as a unit by its commander, brigades into divisions, and these into corps. Baggage, subsistence, and ordnance trains were in like manner systematically organized. Even the ambulances, under command of quartermaster's officers, marched by divisions or corps, so as not to interfere with the evolutions of the troops in case of an encounter with the enemy. Yet the hospitals were left as a series of disconnected units, to co-operate as humanity or the occasional order of a commanding officer might dictate.

This was owing to the non-combatant status of the medical officer. His duty being to give an opinion when required on sanitary matters, to treat the sick and care for the wounded when brought to him, his suggestions on questions of organization or command were lightly considered, as having no basis of experience. He had no control over the ambulances which carried his sick, none over the wagons which transported his supplies, none even over the selection of site for his field-hospitals, as, not being a combatant officer, he could not be expected to know what would be a proper position under existing military circumstances. He was there simply to render professional assistance to the wounded. Even the medical director—a director in name only—having assigned his officers to the front and rear as above stated, was ordered to take post at the principal depôt and there render his professional services. He and his officers having arrived at the depôts, their efforts on behalf of the wounded might be paralyzed by want of co-efficient action on the part of the supply departments. The chief quartermaster was charged with the duties which properly belong to a medical director. He was, in truth, the chief of the medical department, superintending the removal of the wounded from the field, bringing up their supplies and establishing their hospitals. Medical officers may be said to have been professional *attachés* of the Quartermaster's Department. But this status was not generally appreciated. The medical staff was placed in a false position. Its best concerted plans might miscarry by want of support from its actual chiefs. Yet, in the event of preventable suffering to the wounded, it was held responsible by the sufferers and the country.

It was early recognized by the officers of the department that, unless they had full charge of both patients and supplies, they ought not to be held answerable for results. Dr. Tripler, U.S.A., toward the conclusion of his Report on the Peninsular Campaign, attributes the failure of the medical department of the Army of the Potomac to meet a just public expectation, if it did so fail, which he denies : " to a deficiency in the number of officers; to the denial to them of proper official position, they being considered only as ' doctors ' to be called upon to prescribe for a man reporting sick, but not authorized to meddle in any way with the police customs of the camp, or to insist on any measure for the preservation of the health of the men; to the not being permitted to control the means of transportation furnished to them, etc."

To the efficient performance of its humanitarian duties there was needful to the medical department of the army a higher organization on its own part, and the subordination to it of that section of the Quartermaster's Department which was concerned in hospital transportation.

Dr. Tripler, while medical director, took the first step toward organization by establishing brigade surgeons to aid him in the administration of medical affairs, as he found it impossible to oversee so many units and instruct so many officers, most of whom, being fresh from civil life, were totally unacquainted with military usages, camp conservancy, and field duties. Although attached to the regimental system, he found it necessary, in the winter of 1861–'62, to form brigade-hospitals, making details of officers and attendants for their establishment from the regimental institutions. But these were intended simply to relieve the local hospitals, many of which were overcrowded, and they were broken up when the necessity for their existence ceased.

He also attempted the formation of a corps of stretcher-bearers to expedite the removal of wounded from the field; but, as the only men available were the regulation details for duty in regimental hospitals and the musicians of the command, and, as during an engagement the former were required at the depôts as cooks and attendants, while the latter as a body were inefficient and could not be made to obey orders, the plan fell to the ground.

Medical Director Letterman, U.S.A., made a decisive advance to consolidation and higher organization by adopting the system of supplying by brigades. While the regimental hospital carried its own supplies, two and sometimes three wagons were required for each, or rather for the private baggage of officers of the regiment, which was piled into them, the medical officer having no authority to prevent such misapplication of his transportation. But, under the new rule, one wagon sufficed per regiment for the tents, blankets, medicine-chests, etc., and one was found sufficient for the brigade surgeon as purveyor. This reduced the hospital transportation of the army by one-half. But its chief importance, in a medical point of view, was the right of participation in the supply conferred on the wounded irrespective of regimental designation. And, further, the prospect of the supplies reaching the ground when required was

increased, as the wagons containing them were permitted to travel with the ambulances, instead of with the heavy trains. Much loss of stores and stimulants by theft was also prevented by this arrangement.

Having secured the arrival of medical supplies on the field, Dr. Letterman organized the regimental medical officers by divisions into field-hospitals, for the systematic care of the wounded during an engagement. A surgeon was detailed in charge of each hospital, with assistants to keep the records and superintend the kitchens, while to the operating-table carried by each brigade-wagon were assigned an experienced operator and assistants. Officers not on special detail accompanied their regiments to the front, and rendered such aid as was possible. Thus, in the event of a battle, every medical officer knew the duty he was expected to perform, and the labor of caring for a sudden influx of wounded was accomplished without confusion.

Dr. Letterman also suggested plans for an ambulance corps to provide for the transportation of the wounded from the field—plans which, while relieving medical officers from the care of wagons, horses, and harness, placed their use entirely at the disposal of the department. These were carried into effect, and the results obtained were gratifying to every medical officer in the army.

The field-hospital system was tried at Antietam in September, 1862, and was in perfect operation at Fredericksburg in December. The medical officers did their duty satisfactorily on this system at Chancellorsville, in May, 1863, but their results were vitiated by want of transportation. In July of the same year, at Gettysburg, where 21,000 men were thrown suddenly on the hospitals, the medical department did its duty efficiently within the limits of its powers. Surgeons, ambulances, brigade-wagons, with supplies of blankets, chloroform, dressings, opiates, stimulants, and beef-stock, were on the ground, but the trains containing hospital-tents and food-supplies were twenty-five miles distant.

The system adopted about this time, of badging the divisions with a distinctive mark, was of much use in preventing confusion during and after an engagement as well among the wounded as among the regiments in line. The badge of the Second Army Corps, for instance, was a club or trefoil, in red for the First, white for the Second, and blue for the Third Division, worn on the cap by each officer and soldier, painted prominently on the ambulances, and displayed on all hospital guidons and flags. It familiarized the soldier with the unity of the division, making him feel at home where his badge was worn, although surrounded by comrades with different regimental numbers and State names.

The division-hospitals, organized at first for battle emergencies, and broken up as soon as the wounded were cared for and sent to more settled establishments, were found to be convenient institutions to receive sick from crowded regimental hospitals. On this footing they were kept open during the winter of 1863-'64, each in rear of its division-camp, and on the best site available. They consisted of hospital-tents usually pitched on three sides of a square, a plank walk running in front of the tents, with a

weather cover of brush-wood or pine branches raised over it. Two tents were united to form a ward of ten or twelve beds, heated at one end by an open fire-place of brick or clay-lined logs. Officers' quarters, kitchens, etc., were in log huts of tent-size, roofed over with spare flies. Division commanders took an interest in these hospitals and furnished fatigue details for building. Attendants detailed from regimental hospitals did the heavy work, and convalescents sufficed for the light police duties. Many sick were treated in them, who, under previous conditions, would have been sent out of the lines of the army. In one—that of the First Division, Second Army Corps—the wounded in the affair at Morton's Ford, on the Rapidan, February, 1864, 200 in number, were retained and treated until return to duty.

As campaigning had shown the superiority of the division unit in field-hospitals, so the experience of that winter demonstrated its advantages over the regimental unit in quiescent camps. The latter, indeed, came generally to be regarded as an obsolete institution. Much regimental property was, however, still on hand, and had to be loaded on medical wagons at the commencement of the campaign of 1864, increasing the length of the train, but productive of benefit to nobody, as the division-hospitals were charged with all responsibilities. During the progress of the campaign a considerable reduction of the transportation was ordered, when these valueless supplies and property were turned in to the army purveyor, and the regimental hospital became extinct. With the exception of the small medical staff permanently assigned to each division-hospital, all other medical officers, including operators and their assistants, marched and camped with their repective regiments, holding surgeon's call at regulation hours, prescribing for trivial ailments from the field-knapsack, sending less simple prescriptions to the hospital, as to a drug store, to be filled, or sending the patient himself for care and treatment, if his disability promised to be of some duration.

Under the administration of Dr. McParlin, the field-hospitals attained their maximum of efficiency. Experience had manifested that food-supplies were often lacking on the battle-field. To provide for this, a line officer reported to the surgeon in charge of each as commissary of subsistence for the hospital. He became responsible for the food-supply of the wounded. A certain number of rations were then carried with the medical train, which, in the event of a battle, rendered the department independent of the heavy supply-trains, usually many miles from the scene of action. Again, as the order of march sometimes prohibited all wagons, except ambulances, from accompanying an expeditionary column, and as food-supplies had to be provided in such cases for the wounded, a locked box or drawer was fitted under one of the seats of each ambulance. These were packed with so many pounds of beef-stock, hard bread, coffee, sugar, etc., and with field medical supplies, to reinforce the brigade-wagons in case of their exhaustion, or replace them in case of accident.

As organized during the later operations of the war, the medical ser-

vice of the army consisted of permanently established division-hospitals, wherein the sick were treated while in camp, and transported when on the march, and which provided for all the emergencies of battle by serving as the rendezvous for the operative surgeons and their assistants.

They were under the control of the medical director of the corps in all their parts, their personnel, their medical and food suppplies, their shelters, their ambulance- and baggage-wagons. With him rode on the staff of the general commanding a chief of ambulances, who relieved him of the duty of inspecting and preserving wagons and horses in efficient condition, who drilled and disciplined the officers and men of the division ambulances, and who, when it became necessary to use these wagons, received his orders for their distribution and management in collecting the sick and wounded and conveying them to their destination. He was also furnished with a medical inspector, whose duty it was to keep him informed of the sanitary condition of the command while in camp, and, when on the march or in battle, to act as aide in the superintendence of medical affairs. The medical director received the orders, instructions, or suggestions of the commanding general concerning the possibilities of the future, and took his measures accordingly to ensure efficient action in his department.

A surgeon-in-chief accompanied the division general as a staff officer, and had control of the medical department of the command under the orders of the medical director; but, in the absence of orders, he was *de facto* medical director, and acted independently for the best interests of the sick and wounded of his division.

The division-hospital consisted of a surgeon-in-charge, who was responsible on the march for the sick, and in camp for their shelter and comfort, and for the police and general management of the hospital, of which he was commanding officer. He received his orders to move or establish from the superior authority of either corps or division headquarters. One assistant had charge of the records—another, of the kitchens. These were their battle-field duties, and on such occasions occupied all their time and attention; but in quiet times with only sick in camp, or on the march with a light sick-list, they were able to render professional or bedside service, and with an attending physician usually sufficed for the treatment of all cases. But, of course, did circumstances necessitate, details from regiments could supply all the assistance required. In addition, there was present for duty an officer of the line, who was commissary of subsistence for the hospital, responsible under the orders of the surgeon in charge for the food-supply, and who also acted as permanent officer of the day, charged with the general police of the hospital, and having under his orders the pioneer party of ten or twelve men, who pitched or packed the tents and performed the necessary guard-duty.

Attached to the hospital, travelling always with it or in connection with it, and camping always in its neighborhood, was the ambulance corps of the division. It formed a separate command, over which the surgeon in charge had no control, but which received orders from the officers under

whose direction he himself performed his duties, to wit: the surgeon-in-chief of division or the corps director.

It consisted of a lieutenant in command, who was quartermaster of the train, and responsible to that department for its material. Under him a subaltern officer was in command of each brigade section, with a sergeant from each regiment and three men for each ambulance—one as a driver and two as stretcher-bearers. The officers and sergeants were mounted.

As quartermaster of the hospital, the lieutenant in command took charge of the brigade medicine-wagons and of those carrying the hospital material, bringing them on the ground along with his ambulances and forage-wagons as a part of his train.

Practically, one ambulance was allowed to every two hundred men of the fighting force, and this allowance was found sufficient to carry the transient sick after the army in its movements, and to bring the wounded from the field to the division-hospitals. To transport them from these to the hospitals at the base, subsistence issues were made to the troops and the empty wagons littered with hay, pine twigs, and blankets, for use as ambulances.

The train of the division ambulance officer—the strength of the command being eight to ten thousand men—consisted of forty to fifty ambulances, three brigade medicine-wagons, and about a dozen army-wagons, carrying forage, rations, hospital-tents, blankets, kitchen utensils, etc. Thirty tents were sufficient for the shelter of the more serious cases of any engagement. Men slightly wounded camped for the time being on the hospital grounds under their shelter-canvas.

When a move was proposed, the medical director promulgated the order of march, and at the time appointed the ambulance and hospital train were ready to take position in the column. When the order has been for an immediate movement, the sick and wounded have been placed in the ambulances, tents struck, and all *impedimenta* loaded on the wagons within an hour after the issue of the order. But thorough discipline and experienced men are required for such results. The train took its place in the column, usually in rear of its corps, sending a detachment of ambulances and an attending medical officer to the rear of the division, to pick up the accidents of the route.

When the division was ordered into line of battle with probability of an engagement, a site for the hospital was selected by the medical director or surgeon-in-chief, in some sheltered spot, with good water and good roads to the front. In the early battles of the war, houses and barns were always chosen for sites or depôts, as affording shelter to the wounded; in the later, surgeons-in-charge seldom took advantage of such shelter, preferring their tent-hospitals; but the vicinity of a house was often selected, as it formed a good land-mark, and was usually well supplied with water and in good connection with main roads.

Ambulance officers put the roads between the hospital and the line of battle in condition, and selected sheltered places in the immediate rear of each brigade as ambulance rendezvous, where the stretcher-bearers from

the field were relieved of their burdens, and where surgeons not on detail for hospital service gave field attention to the wounded.

In the meantime, at the division-hospital tents were pitched, beds prepared, kitchens opened, operating-tables established, and the various surgeons connected with the institution had reported from their regiments. Everything was prepared for the reception of the wounded, oftentimes long before the first case was brought in from the front, and this without any hurry or confusion, as each officer and man in the command knew the duty which it was his part to perform to complete the hospital work.

At the front, when a man was struck, he made his way to the ambulance rendezvous, if able; but if he fell, the stretcher-bearers, held well to duty by the number of mounted officers and non-commissioned officers over them, took him in charge, thus preventing any straggling from the fighting force on the humanitarian plea of helping the wounded to the rear. The system of the medical department and its ambulance corps was as successful in preserving the integrity of the fighting line as it was in its primary object of caring for the wounded.

The efficiency of this system was tried severely in the campaign of 1864, leading from the Rapidan by way of the Wilderness, Spottsylvania, Cold Harbor, and other fields across the James River to Petersburg, Va. In the early years of the war such a series of battles could only have been fought with much neglect of and suffering to the wounded. As it was, they were received, operated on, and transmitted under medical supervision to the base hospitals, where another section of the medical organization provided for their well-being with a celerity which left the field-hospitals ever ready to follow the command or receive a fresh installment of cases.

Many illustrations could be given of the satisfactory results of the division-hospital system as compared with the unrelieved suffering resulting from that which preceded it. But these are not the pages on which to record them. They can be found in almost every report in the Appendix to Part First of the Medical Volume of the Medical and Surgical History of the War, and they are yet fresh in the memory of many medical men in civil life who followed the flag in those troublous times.

With efficient organization, as described above, and thorough discipline in the field medical department, combined with liberal appropriations for hospital supplies and active co-operation on the part of purveyors, all preventable misery may be removed from the battle-field. The soldier risks life, limb, and liberty in the service of his government, and justice suggests that, if struck down in battle or prostrated by sickness, no considerations of trouble or expense should outweigh his claim to be guarded against all unnecessary suffering. The voice of humanity sustains him in the expectation of such care, for no great war is now undertaken without the formation of Volunteer Aid Societies for the amelioration of his condition.

A paragraph or two on these societies may close this section.

If such institutions are of value, other than in the moral point of view as expressive of a sympathy strong enough to be practical, the medical

arrangements of the army are inefficient and require reorganization. But, even when of value, their administration works at a disadvantage. It has necessarily less knowledge of coming events and possible necessities, less experience of army usages, and less influence in military circles, than the medical department, however imperfect in organization. The good accomplished by the funds of the society is thus proportionally less, for the amount expended, than if turned into the hands of the official administration. While as to the personnel: enthusiasm in individual cases may enable the worker to be of value, but, as a rule, it cannot be expected that volunteer aid, subject to no orders and uncertain as to the progress of events, will be as efficient in the confusion and dangers of the battle-field, as if subordinate to existing authority and laboring in co-operation with the system of the department.

Possibly in no army could aid societies have had greater consideration paid them by military men than in ours, yet the battle-field was not the scene of their best labors, but the base and other sedentary hospitals where the wounded were treated after the field medical organization had been relieved from their charge. So, in Europe, the aid furnished will be found to be, not succor at the moment of injury, but attention and comforts after the wounded are aggregated in the hospitals, barracks, and churches of the nearest city.

Liberal governments should render these services unnecessary; but, however satisfactory the governmental provision, it is probable that a sympathetic humanity would subscribe funds, and the enthusiasm of individuals carry them to the neighborhood of the hospitals as an irregular force of volunteer aid.

Where the Medical Department of the army is all it ought to be, volunteer aid societies are, to say the least, needless. Where it is inefficient, they are useful—not so much from the aid they contribute on the battle-ground, but as pointing out alike to public officials and public observation the necessity for improved methods. Probably the greatest good effected by our Sanitary Commission during the war was the influence it exercised in liberalizing supplies and hospital accommodations, by demonstrating that the country held money as valueless in the face of human suffering.

In the later years of the war, and now that the sick and wounded soldier is provided with a liberal medical supply, it seems strange and sad, as illustrative of the pernicious economy of army rules at that time, to read in the Report of the Medical Director of the Army of the Potomac that, during the winter of 1861: "The prophylactic use of quinine and whiskey having been suggested as a means of preventing malarial disease, I determined to test its efficacy. There being no warrant for such an issue in the regulations of the army, I procured a small quantity from a Sanitary Aid Society," etc.[1]

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[1] Surgeon Charles S. Tripler, Medical Director U.S.A., in Appendix to Medical Volume of History of the War.

SECTION X.

ON THE CAMPS OF CIVIL LIFE.

The principles of camp hygiene are the same for the citizen as for the soldier, whether the camp consists of the tent of a solitary hunter, the log-hut of a settler, or the temporary habitations of the people in their summer exodus from the cities in search of cooler breezes and purer air.

The camp should be laid out in accordance with some definite plan, that the sinks or kitchens of one set of quarters may not be in closer proximity to the occupants of neighboring shelters than is desirable. The streets have to be wide, as they are the only common ground or promenade; and the intervals between tents sufficient not only for police and ventilation, as in the military camp, but for domestic privacy, when such is required by the composition of the population. All of which insures the camp-area against overcrowding.

Military necessity often requires the occupation of an unhealthy site. The civilian's liberty of choice is never controlled in this imperative manner. Nevertheless, miners, agricultural settlers, cattle ranchmen, and others have their selection narrowed by business considerations; while explorers, surveyors, emigrants, and pleasure-parties in route camps have site in its general aspect forced upon them by the character of the country through which they are passing, and by the necessity of a water-supply to camp. The question of site in these cases merits due consideration, as health may be impaired by an injudicious decision.

But in all civilian encampments intended as pleasure or health resorts there should be no doubt of the salubrity of the site selected. It should be dry, and present the dry neighborhood with wood, water, and grass, which insure freedom from miasmatic disease, and from dust, mud, and sun-glare. Advantage is to be taken of the natural features of the country for shade or shelter, as the season may require.

For the mass of our population who cannot afford to pay hotel charges at seaside and mountain resorts, there are great hygienic possibilities comprised in the plan of camping under canvas for a few weeks during the hot season. Many islands around the mouth of Portland Harbor, Me. (the present station of the writer), are in summer converted into seaside camps. Half a dozen small steamers find occupation in carrying picnic parties to the islands, and recruits and supplies for the encampments. Tents, cooking-stoves, and utensils can be rented by the week, month, or season, at a comparative trifle, so that the citizen has to carry with him only the bedding, table-ware, and personal belongings of himself and family. Experience is necessary in "camping out," to derive the benefits without risk from accidental exposures or inconvenience from the want of accustomed facilities; but such experience need not be personal, if the in-

dividual can profit by that of his neighbors of longer standing in the camp community. Other cities, with favorable sites in their vicinity, might adopt with advantage this method of summering.

The tents should be of good cotton duck, weighing at least ten ounces to the linear yard. Ventilation must be provided for by apertures in the roof, protected, in the wall-tent, by the fly—the best method—or, in the flyless tent, by an overlapping flap. In calm, damp weather, when the pores of the canvas are closed by contraction and thickening of its fibres, the ventilators are especially useful, while on sultry afternoons their cooling influence is distinctly marked. In the erection of log-huts or light boarded quarters, attention must be paid to all sanitary considerations.

In cold weather, when the tent cannot be warmed sufficiently by a camp-fire opposite the open entrance, the rear wall must be cut and a fireplace built. The open fireplace is by far the best means of warming a tent or hut. Stoves are worse than useless, except in very large tents, especially where wood is used as fuel ; the small tent becomes quickly overheated, and, when the fire is permitted to die out, it as rapidly cools. The *California stove* has been eulogized by many, but the air of the tent becomes more or less pervaded by irritant products of combustion, while accidents from fire are common. It consists of a sunken fireplace in front of the tent, with a flue running under its floor, the smoke, flame, and hot air being drafted through the flue by a chimney in rear. It is, in fact, a reverberating furnace constructed under the tent.

Overcrowding in tents or huts during the night, or during the day when inclement weather calls for the closing up of all apertures, is a common infraction of sanitary rules among the miners, herders, and emigrants of the West, and not unfrequent in the summer camps of the East. The pure air which bathes the exterior of the tent is no protection against the deleterious effects of the impure air within ; and while camp-life invigorates the system and inures to exposures, animal poisons are not included among the influences against which powers of resistance are accumulated. Nor does exposure to their influence conduce to the invigoration which is aimed at by life in camp.

Where the camp-site is all that it should be, the ground surface, with good local trenching, may be used as the floor of the shelter, premising that it is to be occupied only as a shelter, and not made to do duty as a dining-room. With dampness in site, a raised board floor covered with oil-cloth is needful. But in all cases bedsteads should be provided, raised as high as the form of the tent will permit. When circumstances require the civilian to spread his blankets on the ground, a waterproof poncho, rubber sheet, or piece of oil-cloth, should form the basement layer.

A searching police system is as essential in the civil camp as in the military, but it is seldom that it can be so well carried out, as the citizen, unless in extreme circumstances, would rebel against an iron-handed despotism like that of the military rule, even if exercised for his well-being. Perfect cleanliness is needful in the small camp as in the large, for if soil contamination and consequent injury to health are out of the question

on account of temporary occupation and paucity of individuals, physical comfort is dependent on a thorough police. Any one can appreciate this who has been fretted beyond endurance in a foul summer camp by an endemic of the fly-pest. Besides, comfort from the side of the æsthetic sense is incompatible with the customs prevalent in an unpoliced camp.

Tenting-out, or "*roughing it*," legitimately implies exposure, within limits, to vicissitudes of temperature, weather changes, and the fatigues of out-door life, by which the health and strength may be improved ; but it by no means includes exposure to the foulness which settles on a neglected camp-ground, or to the miasms which may arise therefrom. Nor is this condition to be accepted as a consequence of the camping-out—an inevitable to be endured like the nauseous taste of a salutary medicine. The labor necessary to prevent it is the inevitable, and should be recognized as such. And further, while many of the luxuries of civilization are unattainable in camp, it does not follow that any of the essentials of health, of which cleanliness is one, are to be given up. The plate on which the trout or venison steak is served in the hunter's camp may be of tin, but roughing it does not imply that the tin may be less free from soil or stain than were it in use in an irreproachable home-kitchen.

In large camps it may seem desirable to institute a general police system, but the cleanliness of camp will depend not so much upon it as on the care bestowed by individuals on the area for which they are responsible. Kitchen refuse may be buried, if the superficies will admit of this disposition ; but, when the density of population approaches that of the military camp, it is better to have it carted away to a selected dumping-ground. Sinks should be at proper distance from the quarters, well sheltered, and any imperfection in their condition promptly remedied. They should be established to leeward of habitations, and on a lower level than the water-supply. General supervision is necessary to prevent infringement by one section on the sanitary rights of other portions of the camp. Where the healthful condition of the whole depends so much on individual action, a knowledge of the principles of camp hygiene must be disseminated. A schedule of suggestions may be framed to meet the requirements of the occasion. A thorough understanding of the military system will provide for all contingencies in civil life.

In seasons of pestilence, when the inhabitants of an infected city fly to camp for safety, the camps formed should be small. Military rule is needful for effective quarantine and police, and, under the circumstances, would no doubt be accepted by the people as a necessity.

As with site, so with the water-supply: certain camps—those of emigrants, surveyors, hunters, etc., while en route—have choice denied them. Precautions must be taken if suspicion attaches to the supply. Portable filters are useful in such cases. River-waters, when turbid, should not be used without filtration. Snow- and surface-waters should be boiled to render their organic matter harmless. The standing camps of miners, ranchmen, and others are best supplied by springs or wells, no matter how pure the river-water may appear.

But all summer health-resorts or pleasure-camps should make use of water that is *known* to be free from organic impurity and wholesome in its inorganic constituents.

The clothing must be suited to climate and season, but extra articles should be at hand for unexpected weather changes, overcoats and wraps against evening chills, and waterproofs for rainfalls. Flannel under-garments are imperative. Wet clothing should be changed immediately, or, if this is impossible, exercise should be kept up until the opportunity is afforded. The limits of exposure must never be trespassed.

The importance of good cookery is as great to the citizen as to the soldier, although his supplies may be more liberal and varied. Camp-life dispenses with many kitchen facilities, and thus erases many made dishes from the bill of fare. But those retained should be served in perfect condition. The shortcomings of the camp-fire or kitchen-range must not be allowed as valid excuse for bad cookery, for nothing should be attempted save what the camp facilities can accomplish. Heavy or alkaline bread, lardaceous pastry, half-cooked vegetables, over or underdone meat, fries, and greasy soups, are not necessary consequents of camp-life, any more than are the kitchen-garbage, slops, and vegetable refuse of a deficient police system. Camp hygiene is intolerant of bad cookery.

Having thus briefly indicated the more frequent infractions of camp sanitary laws, it remains to be noted that the application of what has been written extends much further than to the summer camps of a fraction of our eastern population and the makeshift habitations of western adventurers. The camps of civil life occupy a larger field than appears at first sight. This can be best realized in the Territories, where a camp becomes recognized as a village or town without change in the hygienic conditions of the majority of its population. The surface on which the habitations are erected may not even be trenched, the floors may be on the ground level or below it, or, if raised and boarded, may cover a hot-bed of organic decomposition. The shelter, on occasions, may be as imperfect as that of any tent, and ventilation on others as deficient. Even if the area is not crowded, continued occupation pollutes the soil, it being the depository of all organic refuse and excreta, and the water-supply may become pernicious by infiltration. Here are all the general unsanitary conditions of camps to originate disease and propagate specific germs into endemic virulence. Scattered settlements and many villages throughout the country are, from the hygienic point of view, as truly camps as the winter quarters of a military detachment on field-service—density of population as a polluting factor being offset by deficient police and permanent occupation. In individual cases, camp conditions may be said to disappear with the advent of subsoil-drainage and cellarage; but a large settlement does not pass from under the government of camp sanitary laws until a system is instituted for the removal of sewerage and organic refuse, and a water-source provided free from any possibility of contamination by its consumers.

HYGIENE

OF THE

NAVAL AND MERCHANT MARINE.

BY

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HYGIENE

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NAVAL HYGIENE has for its province all that concerns the health of a special class, which is composed of individuals of only one sex and of limited ages, and whose occupation is pursued under conditions which are so arrayed as to be in almost absolute defiance of all sanitary laws. Nevertheless, it is among this class of individuals and under these unfavorable conditions that preventive medicine has demonstrated its economic and social value.

The necessities of commerce, the demand for its protection, as well as the integrity of nations, have changed the models of the ships of half a century ago; and legalized enactments based upon the results of scientific sanitary research have also modified the conditions of ship-life since that period, so that a steady advance for the better is the characteristic of Naval Hygiene at the present time. All the improved and improving surroundings of the seaman of to-day, however, have only been attained by much demonstration, more argument, and at the expense of many lives, for the conflict has been and still is against ignorance, selfishness, and the inertia of conservatism. No sanitary code exists at present in the naval or merchant marine, and much of the hygienic management of the sailor and his environments is still founded upon those vague quantities, the so-called "usages and customs of the sea service." That a code plenary in extent, mandatory in character, with punishments for its infractions, is necessary, can readily be demonstrated from the logs of such vessels as the "Cultivator," "Empire State," "Ringleader," etc.—examples of unsanitary surroundings that would have disgraced barbarism, if possible, rather than the enlightenment of this century. The observation of some years leads me to think that such a code would not be inapplicable to the naval service.

Despite this neglect, great progress has been made in the sanitary condition of ships and crews, and thus it is that to-day the scourge typhus has almost lost its synonym of "ship" fever, and that scurvy presents but few cases in the returns from ships and hospitals for seamen.

SECTION I.

THE SHIP.

MODERN naval architecture is justly proud of its success in the beautiful models of ships, with their fine lines, great carrying capacity and spread of canvas, great speed under sail, under steam, or under both. Vessels are constructed entirely of wood or iron, or of both, as in the encased or composite ships, and are either wholly propelled by steam or by sails, or by sail and steam.

The word "vessel," by the Revised Statutes of the United States, "includes every description of water-craft or other artificial contrivance used or capable of being used as a means of transportation on water," and it is to be "understood to comprehend every description of vessel navigating on any sea or channel, lake or river." English jurists define vessel as synonymous with ship, and a ship is declared to be every description of vessel navigating on the sea.

The shape of vessels has differed very little in all times, and the sharpened log of the Australasian, as well as the fragments of the vessels of the Vikings as figured in Parker's "Fleets of the World," are, as it were, but the pre-Raphaelite sketches of that which has progressively developed and found expression in such vessels as the "Niagara" and "Sovereign of the Seas." This form, however, has been principally determined by the effort to secure speed, to diminish the resistance offered by the water, as well as to attain capacity with stability and strength. Little also has been changed inboard ; as the size of ships has increased, so necessarily has the division of the enclosed space; and thus, from a vessel with but one deck covering the hold, we come to those of two and three decks, making compartments analogous to the stories of a house. In vessels of war such decks have received different names. Thus, the *orlop*, the lowest deck, is below the water-line, dark, ill-ventilated, and seldom or never inhabited. Next above this is the *berth-deck*, the sleeping apartment of most of the crew ; it is below the water-line, and, in vessels with but one fighting-deck, has more light and is better ventilated than the orlop. Above this, in some vessels, is the *gun-deck*, which is above the water-line, has improved conditions as to air and light, and is also used as a sleeping apartment for the crew. Above this is the *spar-deck*, the only open air-space in the vessel. On this deck, in vessels of war, are generally found the apartments of the commanding officer. On the berth-deck are the apartments of the other officers. The hold is generally divided into compartments by transverse vertical partitions, and these spaces are named, from forward aft, the *fore-*, *main-*, and *after-holds*. In steamers the engines and boilers are situated generally between

the main- and after-holds. Below the orlop are the *bilges*—that part of the ship upon which she would rest if ashore. Here also are the *limbers*, which are holes in the flooring permitting the water which comes through the seams of the vessel to collect near the pump-wells. These are the sewers of the ship, and have given a name to a water and characterized a stench.

On the spar-deck forward is the *forecastle*, a place famous in song and story. In naval vessels this is usually covered in by a deck extending some distance aft, and is the resort of the crew when not on watch in wet weather; in merchant vessels the forecastle is the place for the bunks, or sleeping-berths of the men. Aft are the quarters for the captain and passengers. The rest of the vessel is used for stowing cargo. Some merchant steamers have the same berthing-decks as exist in men-of-war, but bunks are used instead of hammocks.

The number of the crew in merchant vessels is dependent upon the opinion of the captain and owners; the number of passengers is determined by statute. Thus, in the merchant marine of the United States the number of passengers is not to be greater than one for every two tons of the vessel, and it is also provided that the spaces appropriated for passengers shall be 16 clear superficial feet of deck, if the height between decks be not less than 6 feet; on the orlop, if used, 18 clear superficial feet of deck, if the height between decks be not less than 6 feet, and if the height between decks is equal to 7½ feet, then 14 clear superficial feet must be provided. No passenger is to be carried where the height between decks is less than 6 feet. Two tiers of berths, only, are permitted, and they must be 6 feet in length by 2 feet in width, with an interval between the lowest berth and the deck of not less than 9 inches. The British Merchant Shipping Act assigns to foreign ships with British seamen 54 cubic feet for each person, if sleeping in hammocks; if not, 72 cubic feet. In addition, each individual is allowed 12 superficial feet on deck. The regulations for transports under military control provide that there shall be only one person for every 2.7 tons. In vessels of the United States Navy the cubic space per man varies with the complement, but the following table from official sources may be accepted as the general average amount in the vessels named:

Wabash	176	cubic feet	per man.
Franklin	175	"	"
Shenandoah	96	"	"
Tuscarora	93	"	"
Kearsage	81	"	"
Richmond	68	"	"
Kansas	60	"	"
Swatara	58	"	"
Yantic	45	"	"

The Yantic has the smallest allowance of cubic feet per man of any

vessel known to the writer ; it is less than the 50 cubic feet allowed a coolie in his transit across the Pacific in vessels of the size of the "Pekin" and "Oceanic." Cameron, writing of the unsanitary condition of Irish canal-boats, states that he found in one 61¼ cubic feet, and in another 133⅓ cubic feet for each person.

In this general sketch of the habitation of the sailor the fact will be at once apparent that here the questions of density of population and of overcrowding are presented for consideration, as well as the attendant necessities for air and cleanliness. Other special points relating to the hygiene of a ship will also suggest themselves.

It is a known law that the total deaths of a community are in a direct ratio to the crowding of the inhabited area, and that the sick rates are likewise proportionate. De Chaumont, in his essays on State medicine, presents tables with curves of population per acre, and number of deaths per thousand from phthisis, respiratory diseases, and the two combined (these are the most frequent causes of death to the sailor), and their parallelism is complete ; he also thinks that there can be no doubt that "the mere aggregation of human beings exercises a powerful influence on their health and vitality. Apart from the determination of specific disease, such as phthisis, overcrowding and foul air tend to increase the spread of all zymotic diseases, particularly those looked upon as contagious." The law holds good in the case of vessels overcrowded with emigrants, and, sooner or later, finds compensation for the cupidity as well as the careless criminal legislation that huddles human beings together, in the diminished health and shortened lives of those who follow the sea. The sailor's wages are not alone for his labor, they are partial payments for his life ; he is of a short-lived race, and is aged before his time. Of ships in general, Turnbull gives as his experience that the larger the vessel the more sickly it is, and adds that it is not the size of the ship which renders her so, but the poorness of the accommodations which are provided for the hands.

In regard to the *hold*, it should always be kept as dry as possible, and the pumps should be used so frequently as never to allow the bilge-water to accumulate. "It would indeed be preferable," and I again quote Turnbull, "constantly to keep the hold nearly dry, were it not that putrid matter is apt to collect there, and that the accumulation of a certain quantity of water, to be afterwards pumped out, becomes necessary to wash off whatever is offensive." These suggestions were written before the days of steamers, but to-day have a tenfold more important value.

In regard to the *bilges*, their characteristic odor depends upon "bilge-water." This collects in the lowest parts of the vessel by filtration through the seams. It has a strong odor of ammonium and hydrogen sulphides, and their presence is easily recognized by the reactions with lead and logwood papers and sodic nitroprusside. These compounds are the products of the decomposition of organic matter in contact with the sulphates in sea-water. Their presence is the evidence of the existence

of organic matter, and that such matter is undergoing destructive metamorphosis.

It must also be remembered that these compounds, when inhaled in varying amounts, have a peculiar poisonous effect on the blood-corpuscle, and that the phenomena of such action range from headache and narcosis to syncope and death. Daniell ascribed the coast of Africa fevers to the presence of hydrogen sulphide in the air ; with modern chemistry at hand it is safe to assert that such diseases have their origin in organic matter, and that the presence of hydrogen sulphide is the evidence as well as the product of filth fermentation. A concentration of the sea-water appears to take place after its entrance into the ship. Parkes states that seven days after the bilges had been sluiced, the specific gravity of the bilge-water was 1031 at 74° F., that of sea-water being at the same time 1021 at 71° F. In a vessel where the bilges had been cleaned the day before, the following observations were made by the writer : "Yedo Bay. Bilge-water, dark smoky color, slightly translucent, bitter saline taste; smells strongly of hydrogen sulphide; blackens lead paper, darkens logwood paper, strongly alkaline to turmeric paper; specific gravity 1024 at 90° F.; specific gravity of sea-water alongside, 1024 at 71° F." Observed on the second day, the same reactions were obtained, but the specific gravity was 1024 at 82° F., the specific gravity of sea-water alongside being 1022 at 72° F. When the bilges had not been cleaned for two weeks the bilge-water was of the color of dilute ink, with black flocculi floating through the specimen ; specific gravity 1022 at 82° F., the sea-water alongside having a specific gravity of 1018 at 82° F. These specimens and many others were examined with the microscope, a one-tenth dry objective being used. A few woody fibres, some silicious particles, coal-dust, woollen fibres, etc., were found, but no living organisms, although a thorough search was made. An angüillula, however, has been reported as living in such water, and a figure of the animal is given.

As has been stated, hydrogen and ammonium sulphides exist in bilge-water; the presence of these compounds is an evidence of decomposing organic matter, and they are poisonous of themselves. It would seem, therefore, evident to the dullest intellect that to remove it instantly when it had collected, and to prevent its accumulation, would be the remedial sanitary measures indicated ; yet it is within the experience of many naval medical officers to confirm this statement : that the bilges have been cleaned only to have fresh sea-water pumped into the vessel under the specious delusion that by this means the ship will be kept "sweet and clean."

In regard to the forecastle in merchant vessels, it beggars description for overcrowding, want of ventilation, and filth. The bunks are but harbors for vermin ; the mess-chests serve for tables ; unaired bedding, wet clothes, and all manner of dirt find a resting-place in the forecastle. Wilson, Judson, Heber Smith—every writer upon marine hygiene bears testimony to the loathsomeness of the surroundings of this pen. Mr.

W. S. Lindsay, a large ship-owner and builder, the author of "Merchant Shipping and Ancient Commerce," thus describes the forecastle of the vessel in which he served his apprenticeship: "At all times it was a foulsome and suffocating abode, and in bad weather the water and filth which washed about the deck and among the chests and casks created the most intolerable and loathsome stench."

The general hygienic management of a ship may be summed up in a few sentences: to avoid the evils of too dense a population, increase the area by giving more cubic space and lessening the number of passengers; if this cannot be done, according to the views of builders and owners of vessels, then furnish an unlimited supply of fresh air; in the forecastle use hammocks instead of bunks, and secure more air, more light, and more dryness; for the hold, bilges, and all spaces below the spar-deck, there is but one rule, one law, viz.: *cleanliness* and *dryness.*

SECTION II.

THE SAILOR.

Every person, apprentices excepted, who shall be employed or engaged to serve in any capacity on board, shall be deemed and taken as a seaman. By law, also, the limit of age for entrance upon this apprenticeship to the art and mystery of a mariner is "not less than twelve years, and of sufficient health and strength." The term of apprenticeship ceases at eighteen years of age. No further limit is known to the writer. It will be noticed that no provision is made for a proper physical examination in order to determine what is to be accepted as "sufficient health and strength." Taking into consideration the physical efforts at development within the ages mentioned, the rapidity of the assimilative process, the increased exhalation of carbon dioxide, the respiratory and circulatory functions, the fact that these limited ages embrace the period of adolescence with all its physical and psychical phenomena, and contrasting the work and deprivations required by this occupation, it is difficult to conceive upon what pretext this childish age was chosen. It is the age of rapid growth, for all the phenomena grouped as vital are in more or less activity at this period, and their energy is used in building up the tissues. Within these ages it must also be remembered that physical endurance is not great. Savigny, one of the survivors of the wreck of the "Medusa," in 1816, observed that children, young persons, and the aged were the first to succumb when deprived of food and undergoing great mental depression and physical work. The problem of work in young persons also implies a limitation to the endurance, and the law may be expressed, other things being equally considered, as having a ratio to the squares of the weights of the individuals.

In the English school- and training-ships for boys, certain measurements are taken as standards of physical development. Thus, a boy 15 to 15½ years of age must measure, without shoes, 58.5 inches in height, and be 29 inches around the chest. At the "École des Mousses," founded by the Chamber of Commerce, at Marseilles, boys of 14 years of age are required to be 1.39 metres (54 inches) in height before being accepted.

Surgeon John S. Kitchen, U.S.N., some months before his decease, furnished the writer with the following record, which may serve as a guide to those desirous of investigating the subject :

Age.	Average height.	Average chest measure.	Average age.	No. examined.	No. accepted.
	Inches.	Inches.	Yrs. mos.		
13 to 14	56.5	25.5	13 6	12	4
14 to 15	58.	26	14 5	22	6
15 to 16	60.5	28	15 6	19	3
16 to 17	61.5	28.75	16 5	26	4
17 to 18	63.875	30	17 5	26	3
Total................................				105	20

The observations of Danson, of Dr. Harrison of Preston, cited by Aitken, and those of Ross and Rolston on English training-ships, agree in the main with those given in the above table. It will be observed from the table that the height from 13 to 18 years increased 7⅜ inches, that the average chest measure within the same period rose 4½ inches, and that the increase is more rapid from 13 to 15 than from 16 to 18. Upon physiological grounds, the necessity for a determination of what may be considered "of sufficient health and strength" becomes obvious. The growth of the skeleton involves the growth of the muscles; muscular growth involves movement and work; growth and work demand increased nutritive action ; and these involve the circulation and respiration, with increased vital capacity. The only approach to any physical description of the merchant seaman is found in the shipping articles, a written contract for service, wherein his name, birth-place, height in feet and inches, complexion, and hair are noted. Nowhere is it directed that the merchant sailor shall be examined as to his physical fitness to perform his arduous duties afloat, and the records of marine hospitals exhibit the consequence of this neglect in the cases of phthisis, chronic rheumatism, cardiac diseases, chronic diseases of the skin, etc., which have occurred among this class of men; and these records also show instances where men, so far advanced in years as to be almost helpless, have been shipped and then transferred to the hospital wards. A vessel, no matter how well built, how grandly furnished, how well found in every particular—perfect it may be in all that relates to model or equipment, cannot be con-

sidered *seaworthy* unless her crew is physically competent to manage her in any emergency. Courage and daring, the strong hand and brave heart, belong to healthy men, not to those who are sick. Given such a vessel, what becomes of her in a gale, manned by the aged, broken-down, and infirm? The wrecks on the approaches to New York can answer.

There is a military as well as a financial necessity for the physical examination, registration, and enrolment of our seamen. As our commerce increases, so increases the necessity for skilled labor in this occupation. The risks of valuable cargoes and still more precious lives—sources of wealth to the country—should not be placed in unsafe hands. If ever a foreign war should occur, it would seriously threaten these growing streams of revenue, and would be likely to drive our carrying trade from the seas. In view of such a possibility, it would appear to be a wise policy, even a duty, for the State to foster this trained industry, in order that in the hour of its need it may call upon these skilled men for its protection and maintenance. To-day, were such a danger threatening our growing commercial prosperity, our only resource would be to man our vessels by impressment, thus returning to the barbarism of the press-gang.

In the naval service, any person presenting himself for appointment or enlistment is physically examined, and, if not found qualified by the medical officer or officers, the appointment is not approved, or, if for enlistment, the recruit is rejected. No person can be enlisted or received as an apprentice under 16 years of age, the term of service ending upon the arrival at 21 years of age. Sailors in the service are classified by three divisions:

1st. Landsmen—those who have never before been at sea, or who are not expert or skilled enough to be ordinary seamen.

2d. Ordinary seamen—those who have been at sea, and are not as expert or skilled as

3d. Seamen, or those who understand the management of ships in navigation.

The naval regulations provide that no one is to be enlisted as a landsman who is over 25 years of age, unless he has some mechanical trade, nor over 34, without authority; an ordinary seaman must have been two years at sea; a seaman four years, and must pass a satisfactory examination. In steamers, the requirements for a fireman are a knowledge of the use of smiths' tools and ability to manage fires with different kinds of fuel. Coppersmiths, boiler-makers, and machinists must be not less than 20 nor more than 40 years of age, with some knowledge of their respective avocations. The applicant for enlistment, on presenting himself, must be sober and clean. He declares, or not, as the case may be, after explanation of a certificate of physical examination, that he is not subject to fits, stricture, internal piles, or any disease that he is aware of or likely to inherit; that he is not suffering from the consequences of any former disease or hurt; and that he knows of no reason why he should not be enlisted. The medical examiner signs a descriptive list of the physical condition of the applicant, embracing name, date, and place of birth,

complexion, hair, eyes, and other personal characteristics, with such facts regarding former place of residence, occupation, and family history as can be obtained. To these are added the more important items of physical measurement. Thus, after the *age* in years and months, the *weight* in pounds, the *height* in feet and inches, as well as the height from vertex to perineum, are noted. The mean circumference of the chest, with its expansion in inches, the vital capacity as determined by a spirometer, the range of vision according to Snellen's standards,and the ability to recognize the ordinary colors used in signalling, are also registered. The instructions for the government of medical officers of the navy thus detail the method of physical examination :

General Surface.—Applicant, entirely nude. to stand erect before the examiner in a broad light, and present front, rear, and sides successively. Note retarded development, deformity or asymmetry of body or limbs, knock-knees, bow-legs or splay-feet, curvatures of spine, feeble constitution, strumous or other cachexia, emaciation, cutaneous or other external disease, tumors, cicatrices, evidences of variola or vaccination, etc.

Extremities and Articulations.—Applicant to present dorsal and palmar surfaces of both hands ; to flex and extend every finger ; to grasp with the thumb and forefinger and with the whole hand ; to flex and extend, pronate and supinate wrists and forearms ; to perform all the motions of shoulder-joints, especially circumduction ; to extend arms at right angles to body, and then bend elbow and touch the shoulders with the fingers ; to elevate extended arms above the head, palm to palm, then dorsum to dorsum ; to evert and invert feet ; to stand on tiptoe, coming down suddenly, and then lifting toes from ground ; to flex each thigh separately upon the abdomen, and, while standing upon one leg, to hop with each foot ; to perform all the motions of the hip-joint, and to walk backward and forward slowly and at double-quick. Note any disability of extremities or articulations, from any cause.

Thorax.—Note the effects of these violent exercises on the heart and lungs ; observe movements of chest during prolonged inspiration and expiration ; examine by auscultation and percussion, front and rear. Note incipient phthisis or cardiac disease.

Abdomen, Groins, and Genitals.—With hands on the head, and chin up, applicant to cough violently. Note relaxation of umbilical and inguinal regions, hernia, concealed venereal disease, varicocele, orchitis, etc.

Spine and Perineum.—Applicant to bend forward with knees stiffened, feet wide apart, hands touching the floor, and nates exposed to strong light. Note hæmorrhoids ; prolapsus ; fistula. While stooping make firm pressure on each spinous process of the vertebra. Note spinal tenderness.

Head, Face, and Neck.—Motions of the head, neck, and lower jaw. *Cranium.*—Note depressions, cicatrices, malformations, etc. *Ears.*—Note polypi, otorrhœa, dulness of hearing. *Eyes.*—Note absence of cilia, obstructed puncta, corneal opacities, adhesions of iris, defective vision, color-blindness, etc. *Nose.*—Note polypi, ozæna, chronic nasal catarrh. *Mouth, teeth, tongue, fauces.*—Note hypertrophied tonsils, impediments of speech, syphilitic affections. The *intelligence* of the applicant will be evident from the character of the replies to inquiries respecting former residence, occupation, family history, etc. The *age* of the applicant must be constantly kept in view in determining the standard of physical qualifications.

The whole object of the examination is to secure for the naval service active and able-bodied men. Some few practical hints may serve as helps in this matter of physical inquiry. Men of average height, with long bodies and short legs, have most endurance; those over the average height

should be carefully scrutinized. The between-decks of many ships does not permit men over the average stature to walk upright. The thin, as well as the obese, have but little endurance. Long-armed men do well at the guns as spongers and loaders; short and stout men at the handspikes; choose men of good intelligence for captains of guns' crews; light and active men do well as topgallant and royal-yard men. In examining men for the engineer's force, regard must be had to the high temperatures to which they are exposed. Coal-heavers should be muscular, as the work demanded of them when on watch, measured in foot-tons, is enormous.

It is apparent that this examination secures to the service a class of men whose bodily frames are unexceptionable. It would appear to follow from this fact that the sick and death rates would be low. The reverse is the case; the sick rates of such a picked class of men are high, and its cause is defective sanitation, or rather, no sanitary code whatever.

SECTION III.

AIR.

The earth is surrounded by a gaseous envelope, extending from 45 to 50 miles above its surface, called the atmosphere or air.

This envelope presses on the earth's surface with a force equal to 14.75 lbs. to the square inch, is unvarying in its composition, is a mechanical mixture, obeys the laws of all gases, and is indispensable to the maintenance of animal and vegetable life. In its average constitution the ingredients of the atmosphere appear to be in the following proportions:

Oxygen	20.61
Nitrogen	77.95
Carbon dioxide	.04
Aqueous vapor	1.40
	100.

Some of the accidental ingredients are traces of nitric acid, ammonia, and, in the air of cities, hydrogen sulphide and sulphurous anhydride. The most important of its contaminations, however, to the student of hygiene, is organic matter. The temperature of the air at the surface of the earth varies with the latitude, and the lines of equal temperature around the globe, north and south of the equator, are known as isotherms.

Humboldt estimates the mean equatorial temperature of the air to be 81.5° F., that of the thermal equator to be 84.5° F. On the open sea the air never attains a temperature of 87.8° F. The temperature of the sea seldom rises to 86° F.; and it is stated that at no place on the earth's sur-

face, in any season, will a thermometer at from six to nine feet from the surface, and sheltered from all reverberation, attain a temperature of 114.8° F.

Carbon dioxide.—It is important to remember that it exists in the atmosphere in a normal proportion of 4.15 volumes in 10,000. It may be as low as three and as high as six volumes, according to De Saussure, and still be within a normal range. The amount is increased at night, diminishes towards sunrise, is less over the sea than over the land, is greater according to the relative humidity of the air, and less after a rain, is in a greater proportion in cities than in the country, and is greater in dwellings and crowded places.

The amount of *aqueous vapor* which can exist as such in a given quantity of air depends on the temperature. Thus, the dryness of the air is doubled with every increase in temperature equal to 27° F., and in like proportion for the intermediate degrees. At

32° F.,	air is capable of	holding	$\frac{1}{160}$	part of its weight of	water;
59° F.,	"	"	$\frac{1}{80}$	"	"
86° F.,	"	"	$\frac{1}{40}$	"	"

so that, as the temperature advances in an arithmetical series, the solvent power which this gives the air is increased in a geometrical ratio.

Organic matter.—Moscati, in 1818, condensed from the air of a hospital ward, at Milan, the organic matter, and describes it as "slimy and having a marshy smell." Candido, in 1853, at Rio Janeiro, condensed, by means of a freezing mixture of ice and salt, the air of a room into a liquid, and, by treating this with lime-water in the presence of sunlight, obtained ammonia as the result of the decomposition, thus chemically demonstrating the presence of organic matter; whilst the late researches of Prof. Tyndall have physically exhibited the presence of organized matter in the general atmosphere.

The sailor living at the sea-level is removed from the affections incident to altitudes, as well as from those dependent upon a constant or steady increased barometric pressure, and he is also in a measure removed from the disease-producing causes incident particularly to soil. Beyond that distressing affection, sea-sickness, which appears to be the result of the very small oscillations in the column of the blood, induced by the minute changes in the aërial pressure from the rising and falling of the ship by the action of the waves, but few effects have been described that are due to the variations in the height of the barometer. The success of such vessels as those designed by Bessemer for the transportation of passengers from Dover to Calais may serve to determine the correctness of the above idea as to the cause of *nausea marina.*

Observations upon the effect of temperature, however, demand more consideration. Exposure to *cold* and damp is the most potent factor in the production of scurvy, and crowds the lists of sick with pneumonias, catarrhs, acute rheumatism, frost-bites, etc., and aggravates all venereal affections. A clean, dry forecastle or deck-house, warmed by a stove in cold weather, and a change of dry clothing after exposure to cold and

damp, are the evident hygienic measures to be resorted to under such circumstances. Rapid change from the winter of a temperate climate to the tropics does not appear, from the writer's observations, to be attended with any immediate effect upon the body. The effects of acute exposure to high temperatures are shown more particularly in predisposing to tetanus and inducing insolation or sunstroke. This last affection has frequently been observed on shipboard, where overcrowding and impure air add their death-producing influences to excessive heat. Sunstroke has been known to occur in passenger vessels cruising through the Red Sea in August and September. Bassin reports that in 1823, in the "Lynx," cruising off Cadiz, 18 cases occurred in a crew of 78. The vessel was overcrowded, and the temperature of the air is given at 35° C. (95° F.). Boudin reports that on the "Duquesne," in the harbor of Rio Janeiro, 100 cases occurred in a crew of 600.

MacLean ascribes sunstroke to the effects of a high temperature, night and day, on men unsuitably clothed and breathing the vitiated air of ships, and also notices its frequent occurrence at night when men are in a recumbent position. Heat-exhaustion frequently occurs among the men composing the engineer's force on shipboard, and is marked by profuse sweating, clammy skin, a rise in the temperature of the body, increase in the number of respirations and beats of the pulse, with nausea and vertigo.

As an illustration of an extreme case, I give the following memoranda from my note-book: China Seas—Midnight—Fire-room temperature, 152° F. Body temperature, 98.4° F. Pulse, 69. Respirations, 18. After remaining perfectly quiet in the centre of the fire-room for 45 minutes, the body temperature rose to 103.6° F., the pulsations were increased to 180, and the respirations to 42, when nausea compelled the medical officer making this experiment to leave the fire-room. At 1.30 A.M., the body temperature was 100.2° F., the pulse 144, and respirations 30. The body temperature was taken under the tongue, to which locality the thermometer was passed quickly from a glass of water at 99° F., so that the temperature of the fire-room was not allowed to affect the instrument.

The effects of a prolonged exposure of crews to tropical temperatures is shown by their lowered vitality, an anæmic condition, sallow complexion, general enervation and depression. This condition and its cause were known to the Father of Medicine, and described by him in Sec. 5, Aphorism 16: "Excess of heat induces debility of the muscular fibre, impotence of nerve, torpor of mind, hæmorrhage, fainting, and death." That there is also a tendency to hepatic disturbances of various characters, a reference to the works of Martin, Johnson, Dutroleau, Lind, and many others, will demonstrate. That there is a loss of muscular power and bodily vigor from extended cruises in hot climates can readily be determined by the sick reports from vessels of all navies.

The long-continued exposure to tropical heat of those born in temperate climates involves the interesting study of "Acclimation." Some

study and observation lead the writer to believe that there is no such condition as acclimation, as it is generally understood, or at least, that within historic times no example can be adduced. There is, however, an accommodation, as Aitken has termed it—a pliancy of constitution, according to Nott; a power of adaptation, which is a variable quantity for each individual. The range is greater in males, less in females; is still further reduced in their children; does not exist in a second generation, for it would be an extraordinary thing to find the grandchildren, descended from a grandfather who was born and brought up in a temperate zone, living continuously within the tropics. The average duration of life is shortened in Bengal and Jamaica, according to the exhibit of life insurance tables. Englishmen do not become acclimated in India, nor Frenchmen in Algeria. It is, as Buckle states, that "in the tropics, man brought under the presence of Nature, if not indigenous, succumbs." I am persuaded to believe that the nearer the approach, in his adopted country, to the same climatic phenomena (for instance, under the same isothermal lines) that characterize his native home, the greater will be the range of the power of adaptation; and more particularly am I led to believe that the nearer the approach of the ethnic affinities of the foreigner to those of the indigenous race he remains among, the more readily does his "physique" become adapted to the physical surroundings, but never absolutely and entirely.

There is no acclimation for malarial fevers.

Of the influences on the body of exposure to high artificial temperatures we have more exact data. It is recommended by Obernier, of Bonn, that when the thermometer marks 86° to 88° F. in the shade, all exercises of men in masses must be arrested; and this finds a hygienic application in steamers, where the temperature is often at that height, especially when steaming in the tropics. I do not possess any data of the temperatures of the engine- and fire-rooms of sea-going merchant steamers.[1] There is a reluctance in the giving of any information upon these subjects, not only in the merchant marine, but in all navies, and one is compelled to judge of the antecedent conditions by the results as found in hospitals. The condition described by Levick of Philadelphia, and known as the "fireman's heart," indicates at once the cause and locality of diseased action. Indeed, we can readily predict, from the known physiological effects of high temperatures, the pathological phenomena that must necessarily occur. This affection is described as an atonic condition of the heart, and is a direct consequence of the exposure of men to high temperatures in the engine- and fire-rooms. I think it will be found that here Nature demands her compensation from man for wresting steam from her grasp and rendering it subservient to his uses, and also that in the future, affections of the circulatory system will be found first in the list of diseases of seamen.

In naval vessels of the "monitor" pattern the temperature of the en-

[1] The engine- and fire-rooms of merchant steamers are more favorably arranged than in naval vessels, where protection of the machinery from shot and shell is considered the desideratum.

gine-room is known to be excessively high. I can find no record of fire-room temperatures. As examples the following memoranda, copied from the steam logs of the vessels named, are cited, and are official in character:

	Engine-room Temp.	Deck Temp.
Dictator	106° to 115° F.	68° to 84° F.
Canonicus	95° to 114° F.	34° to 66° F.
Saugus	156° F.	82° F.

The above-named vessels are "monitors."

Tennessee	100° to 165° F.	68° to 84° F.
Trenton	95° to 110° F.	64° to 66° F.
Hartford	112° to 130° F.	74° to 83° F.
Ranger	112° F.	82° F.
Alert	104° F.	73° F.
Monongahela	109° F.	82° F.
Swatara	108° to 165° F.	77° to 90° F.

In the last-named vessel the mean for the second quarter 187— was:

Engine-room.........112.7° F. Deck, 76° F.

The above-named vessels are propelled by sail and steam. In vessels with side-wheels of the double-ender pattern, such as the "Monocacy" and "Ashuelot," the temperature was:

	Engine-room.	Deck.
Monocacy	88° F.	62° F.
Ashuelot	84° F.	69° F.

The exposure of the engine-rooms will account for the approach of their temperatures to that of the external air. The *fire-room* temperatures of these vessels must be far in excess of the high temperatures of the engine-room. The writer has a few memoranda of the fire-room temperature of a single vessel. The average temperature at which the firemen and coal-heavers worked was 167° F., with an average external temperature of 84° F. The highest recorded temperature in this series was 181° F., with the external air at 86° F., and the lowest was 149° F., with an external temperature of 82° F. In one instance the temperature of a thermometer encased in wood was 198° F. This reading of the instrument was witnessed by several officers.

The air of the holds of ships frequently becomes heated. The writer has observed this fact repeatedly: that, when distilling water for ship's use, the water was delivered into the tanks at temperatures varying from 98° to 104°. Water thus heated, as it cools is apt to absorb any injurious elements in the surrounding atmosphere. At any rate, the hold becomes warmed up to these ranges of temperature, which are most favorable to decomposition and to the growth of septic vegetable and animal organisms.

Becker has shown that a rise of 1° F. in the temperature is attended with a rise of $\frac{1}{20}$ of a degree of the body temperature, and it follows that a rise of 20° F. in the external temperature would increase the body temperature 1°. Now, a rise of 1° in temperature has its mechanical equivalent in 772 foot-pounds. Again, as the mean daily internal work of the body, principally performed by the heart, is, according to Haughton's observations, 273,280 foot-pounds, it is easy to calculate the additional work imposed upon the heart by these increased temperatures. This would represent an actuality. It would be further increased were we to take into consideration the law of cooling, that is: "that the total amount of heat given out by a heated body is in a ratio to the elevation of temperature above the temperature of equilibrium towards which it tends." All these conditions, so materially affecting the health of the sailor, demand amelioration in a very great degree. It is believed by the writer that a better ventilation of the engine- and fire-rooms will be of benefit to those working under such high artificial temperatures. The engineer's force in our naval vessels is generally divided into three parts or watches. The force should be divided into four parts, for the following reasons, which have their foundations in experiment and observation:

1st. That *at rest* the increase of the external temperature is attended by an increase in the body temperature, and this is mechanical work chiefly imposed upon the heart. 2d. That *at work*, to the above increase must be added the amount of bodily work performed. 3d. That as the heart is a muscle, increased movement brings it, like all muscles, under the law of fatigue. 4th. That the fatigue of the heart is principally evidenced by functional disturbance, such as palpitation, etc., and it is a well-decided pathological law that "long-continued functional disturbance produces organic lesion." 5th. That bodily rest—physiological rest, in the open air, is, as is well known to every physician, of extreme value in all affections of the cardiac viscus. 6th. That every degree of rise in the body temperature is indicative of a corresponding decline in that nervous control which regulates the functions in health. The slowness with which the heart resumes its normal action after exposure to high temperatures is evident in the details of the fire-room experiment. As these men are enrolled under special provisions, they should not be called upon for any duty outside their vocation. There is a physiological, and consequently a hygienic necessity for this. It is no uncommon thing in vessels propelled by sail and steam to have all the engineer's force, not on watch, engaged in pulling and hauling on sheets and halyards on deck, only to go below and take up their work in the engine- and fire-room when the watch is changed. It is all wrong, no matter from what standpoint it may be viewed. After a watch they should not be disturbed except in cases of great emergency.

Statistics furnish additional evidence in regard to the morbific effects of high temperatures. Thus, on a scale of 100, for the last half of the year 1875, there were admitted to the sick report of a naval vessel:

Of the engineer's force	156
All officers and others	94
In 1876:	
Of the engineer's force	161
All officers and others	165
In 1877:	
Of the engineer's force	168
All officers and others	149

The first six months of the cruise were spent in sailing and steaming to the station, 1876 was spent on the station, and 1877 partly on the station and partly in sailing and steaming home.

Carbon dioxide.—The normal amount of carbon dioxide, as has been observed, is 4.15 volumes in 10,000 of air, and an increase to six volumes may be considered as the limit consistent with health. The quantity of this gas existing in the atmosphere has been taken under certain conditions as the measure of the really important impurities of the air, and a somewhat extended experimental research in this direction by the writer leads him to assert with Billings, "that it is about the only available test for this purpose." According to Pettenkofer, an adult male at rest gives off about 0.7 of a cubic foot of dioxide per hour, with a proportionate amount of organic matter. It may be considered, however, to be about eight cubic inches for each pound of body weight, or 0.6+ cubic feet per hour, according to more accurate observations. From the numerous experiments of medical officers of the navy, made under official regulation, the amount of gaseous impurity of the air on our national vessels is found to exceed by many times the limit assigned as consistent with health. The amount of carbon dioxide, at various times on board of different naval vessels, has ranged from 11.8 to 39.1 volumes in 10,000 of air. Now, a single person in one minute of time, *at rest*, and breathing normally—*i. e.*, 20 respirations, with 20 cubic inches of air per minute for each inspiration—will vitiate 50 cubic feet of normal air, and it requires but little calculation to demonstrate that there is not for any one instant of time air normal in quality on the lower decks of our national vessels. This matter is rendered more decidedly evident, when it is considered dynamically, for a man *at work* exhales more CO_2 than when at rest. Pettenkofer and Voit found that a man weighing 60 kilos at rest gave off 911.5 grammes of CO_2 in 24 hours, and during exertion 1284.2 grammes. Edward Smith found that an individual during sleep exhaled about 19 grains CO_2 every hour, and when he walked three miles an hour the amount was increased to 100.6 grains. Scharling says that about one-fourth less CO_2 is exhaled by an individual when asleep than when awake. The amount exhaled is also increased by moist air up to a certain degree and diminished by an increased temperature. The apparatus used in the naval service for estimating the amount of carbon dioxide in the air consists of the following articles:—

Two glass jars, cubic capacity marked in cubic centimetres.
India-rubber stoppers, and sheet india-rubber to tie over neck of jars.
Glass measure graduated to 60 c.c.
One Mohr's burette, 60 c.c., graduated into tenths.
Glass rods.
Glass bottle of one litre capacity.
Bottle containing papers of crystallized oxalic acid of 2.25 grammes each.
Bottle containing litmus or turmeric paper.
A small bellows, or, in its absence, a Davidson's syringe may be used.
Lime-water and distilled water.

Directions: Pettenkofer's method is to be followed. For those not familiar with it the following process, extracted from Wilson's Hand-Book of Hygiene, is recommended:

The analysis depends on the relative alkalinity of lime-water before and after it has absorbed the carbonic acid in the sample of air examined. 2.25 grammes of crystallized oxalic acid are dissolved in 1 litre of distilled water; 1 c.c. of this solution exactly neutralizes 1 milligramme of lime, and hence the amount of lime in a given quantity of lime-water can be determined by adding the solution of oxalic acid until the point of neutralization is reached. The amount of oxalic acid required for neutralization expresses the alkalinity of the lime-water. If the alkalinity of the lime-water be known before and after it has absorbed the carbonic acid in the air contained in the glass jar, the difference will give in milligrammes the amount of lime which has united with the carbonic acid, and the amount of the latter is obtained by calculating according to the atomic weights.

The jar should be perfectly clean and dry. The air to be examined is forced into the jar by a pair of bellows, or a bellows-pump may be used. In either case the nozzle should reach the bottom of the jar. After the jar has been filled, 60 c.c. of lime-water are introduced, the mouth of the jar closed by the stopper, and the stopper secured by a tightly fitting india-rubber cap. The jar is then well shaken so that the lime-water is made to thoroughly wash the contained air, and afterwards it is left to stand at least eight hours and not more than twenty-four; 60 c.c. are introduced in order that 30 may be taken out for analysis. Thirty cubic centimetres of lime-water are poured into the graduated glass and its alkalinity determined by the test-solution. Then 30 c.c. are taken from the jar and the alkalinity also determined. The difference is doubled to account for 30 c.c. left in the jar, and the product gives the amount of lime which has combined with the carbonic acid. The amount of the latter is obtained by converting weight into volume according to the atomic weights, and in one sum by the factor .39748+.

The following rule will simplify the calculation: Multiply the difference between the alkalinity of the lime-water, before and after it has been placed in the jar, by 795 and divide this sum by the number of cubic centimetres in the jar, minus 60. The result will be the ratio of carbonic acid per 1,000 volumes.

A correction must be made for temperature, according as it is above

or below the standard of 62° Fahrenheit. As the coefficient of expansion of air is .0020361 for every degree of Fahrenheit, the rule for correction may be stated with sufficient accuracy thus: For every 5° Fahrenheit above 62° add 1 per cent. to the amount of carbonic acid calculated as above, and deduct the same percentage for every 5° below 62°.

The formula for the correction for pressure is as follows:

$$30 : \text{observed height of barom.} :: \text{capacity} : z.$$

The result expressed by z is substituted for the actual capacity of the jar in the calculation for carbonic acid.

Organic matter.—The amount of organic matter, the most important of the aërial impurities given off from the skin and lungs, has never been accurately determined, and its correct estimation is still a desideratum. It is known to be made up of epithelial scales, fatty matters, etc., from the skin, and organic matter in the form of vapor from the lungs. The organic matter from the lungs blackens sulphuric acid, decolorizes a solution of potassium permanganate, reduces a mixture of potassium bichromate and sulphuric acid, gives a reddish black color to a solution of silver nitrate, and renders water offensive after standing. It is decomposed by caustic lime in the presence of sunlight, and yields ammonia. The observations of the writer lead him to believe that it is in combination with the watery vapor existing in the air, for with the increase of the latter the organic matter appears to be increased. It is not a gas, but is molecular in its constitution. It is absorbed by woollen fabrics and collects in the damp on walls. Color influences its absorption, black absorbing the most, and blue the next largest amount. No absolutely trustworthy method of estimating quantitatively the amount of organic matter, either in air or water, has, in the opinion of the writer, yet been devised. All the methods so far presented for the use of working sanitary observers are based upon the estimation (by the Nessler solution) of the free ammonia and of the albuminoid ammonia resulting from the destructive decomposition of the organic matter. The writer has also to state that, from an experience of some years with Nessler's solution, he doubts the accuracy of any quantitative estimation of organic matter based upon this method. Its extreme sensitiveness, as well as its dependency upon the varying estimate of the shades of color, renders it at all times questionable. It appears from the observations of Dr. C. B. Fox (1878) upon this method, that the experimental error is increased even by washing the necessary apparatus with distilled water, and he has an average error for his own laboratory. This alone brings this test into uncertainty. At the present time—and the writer expresses the opinion of a number of chemical friends as well as his own—the Nessler test is worthless for quantitative estimations. For qualitative examinations of organic matter, the extreme delicacy of the test renders it invaluable.

Moisture.—"A damp ship is an unhealthy ship." The universal observation of medical officers of all services for over a century has rendered the above statement axiomatic. Yet in an experience of twenty-five years

the writer cannot recall, either from memory or from memoranda, a dry ship. Air is dry or moist, not in proportion to the amount of water which it contains, but according as it is more or less removed from saturation. This degree of saturation is expressed by the term *relative humidity*, and is usually represented numerically—saturation being taken as 100. According to Lévy, the average normal relative humidity of the air is 72. The capacity of air for moisture depends upon the temperature, as has been previously mentioned. The observations of the writer upon the relative humidity of the air of naval vessels commenced in 1855, and were abruptly and arbitrarily terminated, through ignorance, by order during his last cruise on the Asiatic station. On an average the air of the lower decks is always of a greater relative humidity than that of the spar-deck or open air. This is an unavoidable result when it is considered that the routine of naval vessels directs either scrubbing, washing, clamping, wiping-up, or holystoning of the decks every day in the week. This constant wetting is now ostensibly left to the discretion of the commanding officer, but was formerly left to the caprice or opinion of some subordinate or petty officer, who had fallen heir to this legacy of Von Tromp, of wet decks, but who had not the gallant old Hollander's excuse for making the vessel as much as possible like his home with its dikes.

From the skin and lungs of a person at rest there is exhaled, in the 24 hours, from 20 to 30 ounces of water. To maintain this amount of water in a state of vapor requires about 211 c. feet per hour, at the ordinary temperatures and pressure. This necessary amount is modified by the temperature and the hygrometric condition of the air. At work, about 68 ounces are given off, or about 1,240 grains per hour.

Lehmann's observations demonstrate that the weight of carbonic acid excreted is increased in a moist atmosphere, and that the effect of a high temperature is to diminish the exhalation of CO_2 from the lungs. Now, the influence of moisture is so great that, at high temperatures, it neutralizes the effect of such temperature in diminishing the elimination of carbon dioxide. Again, as a general rule, the expired air is saturated with moisture, so that when the temperature of the air comes to be the same as that of the body, and saturated, no exhalation of aqueous vapor from the skin or lungs is possible, and consequently there is retained within the body this water and the excrementitious matters which they eliminate. It is evident that life cannot be prolonged in such an air at a temperature between 90° and 100° F. It is also evident that the normal exhalations are more than sufficient to render the air in the cubic space allotted to each person on board ship saturated, without having recourse to any artificial means. Few constitutions can or do resist the evil effects of constant dampness, and it is not at all a matter of surprise that the average duration of the life of a sailor has been given as twelve years, and that about 17,000 of our seamen die or are physically disabled every year. The wonder is that the rate is so low under such physical surroundings. The natural humidity of the air at sea on board ship should never be supplemented by artificial means to render it saturated.

For those who may desire some few data for guidance in these matters, it may be stated that a relative humidity should not vary much from 70 to 75. The difference between the wet and dry bulb thermometers should not be less than 3° or 4° F. Briggs, the best authority on atmospheric moisture, assigns 70° as the relative humidity best consistent with health. The air over the ocean has always a greater degree of relative humidity than over the land, and varies slightly in summer and winter. The range has been determined to be from 70 to 75 (saturation = 100). The less also the cubic air space per man, the greater becomes the relative humidity of the air. The point of comfort of the external temperature has been variously assigned, but the range is from 58° to 68° F.

All medical officers are agreed upon the disease-producing effects of humidity. Fox says that, with a temperature of 80° F., air of excessive humidity becomes injurious. Blane states: "We may, therefore, consider it as an ascertained truth of the utmost importance, that moisture, whether adhering to clothes or to the sides and decks of ships, or floating in the air, is pernicious to health, and that one of the principal means of preserving health consists in obviating it;" and further observes that "the decks should not be washed so often when the weather is moist as when it is fair, as it will be more difficult to dry them, and more harm may arise from the moisture than benefit from the cleanness." Turnbull says: "Moisture acting more powerfully than any other cause in the production of disease, as well as in the propagation of it, our first care was to endeavor to remove all humidity and foulness of the air." In 1792, Clark, in writing upon the diseases of long voyages, remarks: "The diseases occasioned at sea by heat united with moisture are fevers and fluxes;" and, when treating of the means of obviating the ill effects of heat, coldness, and moisture, he recommends, in the conclusion of his article, "to dry up all moisture by placing stoves in various parts between decks." Welch, assistant professor of pathology at Netley, in the Alexander prize essay, says: "The main deleterious property of the general atmosphere is moisture." Again, speaking of the excess of watery vapor in the air: "According as it approaches saturation, it (*i. e.*, the air) tends to impede the exhalation from the lungs and favors congestion. Beyond this, also, the intimate connection between organic matter and hygrometric bodies must not be forgotten."

Simon, speaking of filth ferments, states that "they show no power of diffusion in dry air, but as moisture is their normal medium, currents of humid air can doubtless lift them in their full effectiveness." C. B. Fox remarks in the last edition of his book (1878) as follows: "Aqueous vapor possesses a powerful affinity for organic matter, and serves both to preserve and diffuse it." Again: "An excess of aqueous vapor has not only a depressing effect upon the nervous system, but it interferes with the pulmonary and cutaneous exhalations." "Humidity," says Pringle, "is one of the most frequent causes of the derangement of health." Fonssagrives, the authority on naval hygiene, asserts that "a damp ship is an unhealthy ship." The researches of Rouppe, Kerauden, Raoul, Bourel-

Roncière, and others all tend to exhibit the disease-producing influence of this aërial condition. Wagner, in his Manual of General Pathology, thus alludes to the moisture of the air: "Warm and damp air most impedes the radiation of heat from the body through the skin and lungs, causes exhaustion of the muscular and nervous systems, restrains respiration, diminishes the appetite, impairs the digestion, and increases the perspiration." Sir Alexander Armstrong, the present head of the medical department of the English Navy, says: "There can be no more fertile source of disease among seamen, or indeed other persons, than the constant inhalation of a moist atmosphere, whether sleeping or waking; but particularly is this influence injurious when the moisture exists between a ship's decks, where it may be at the same time more or less impure, and hot or cold, according to circumstances." Trotter remarks, in his Medicina Nautica: "The nature of cleanliness is often misunderstood, and I know of nothing of that kind which is so much mistaken as the too frequent and indiscreet drenching the decks, and more especially those where people sleep, with water. By this means I have known dreadful sickness *introduced*, and I have known it removed by a contrary practice. It would be deemed extravagant to advance an opinion that the decks should *never* be washed, but I feel no reluctance in making a direct assertion that it were far better that they should not be *washed at all* than with that want of discretion and precaution which so generally prevails. It has caused the death of thousands." Guy, W. A., speaking of vessels like the "Centurion" and others of that date, describes them as "damp, filthy, and ill-ventilated," and the history of the cruise of the "Centurion" reads to-day like a romance. "In nine months her crew of 506 was reduced to 214," etc., from cold, damp, and scurvy. The health histories, however, of such vessels, as the "St. Jean d'Acre," "Neptune," "Caledonian," "London," "Renown," "Black Prince," and others in the English navy, and of some of our own, reveal the extent of this nuisance in deteriorating the health of the crews.

Damp heat between decks aggravates yellow fever and is the great cause of disease in the West Indies, and it is an essential factor in the production of all the miasmata. Amidst the diseases induced and aggravated by excessive humidity centrally stand those of the pulmonary organs, with phthisis and other wasting diseases of these tissues, and around them scurvy, rheumatism and its associated cardiac trouble, abscesses, felons, boils, and diseases of the subcutaneous cellular system are grouped. As to its bearing the relation of causation to wasting lung diseases or phthisis and scrofula, Alison, Baudelocque, Ransome, MacCormac, Carmichael, Bowditch, Buchanan, and others all bear testimony to vitiated and moist air as being the most important factor in their production.

As has been stated, the cause of this excessive humidity on shipboard is the almost daily wetting of the decks, and it would seem natural that the arrest of this should be within the range of preventive medicine. The writer believes that the wetting of decks should not be left to the discre-

tion of any officer. Dryness and fresh air are as much matters for the consideration of the legislator as the food, clothing, water, etc., of the sailor. It is known to be the most powerful of the disease-producing environments of the seaman Prevent the cause, and disease is prevented. In the language of an able medical jurist, "Preventable mortality is criminal mortality, and so preventable sickness is criminal sickness."

Contrast, on the other hand, the records of dry ships—few in number, for this evil of dampness is widespread in all navies—and mark the evident result of the inspection. Collingwood's flag-ship, with a crew of 800 men, kept the seas for more than a year and a half with never more than six on her sick-list. This low rate was secured by attention to dryness, ventilation, and a general care of the crew. Admiral Foote diminished the large sick-lists of the "Varuna," caused by excessive wetting of the decks, by abating the nuisance. Medical Director Maxwell's suggestions, which were carried out, saved the crew of the "Powhatan," in China, under like circumstances. Admiral Boggs, when commanding the mail steamer running from New York to Aspinwall, escaped malarial poisoning by keeping his cabin dry. Sir Gilbert Blane very early suggested that cleanliness and dryness were of importance in preserving the health of seamen. Trotter, when physician to the fleet of Lord Howe, rendered that fleet effective by his attention to dryness of the vessels, midst other sanitary measures. To use the words of Guy, "he helped to organize victory" by placing in the hands of his gallant chief the living material of the fleet in a state of first-rate efficiency. The record of Captain Murray, R.N., of H. B. M.'s "Valorous," exhibits the value of dryness on board ships beyond cavil or doubt: "That when, on his arrival in England, in 1823, after two years' service amid the icebergs of Labrador, the ship was ordered to sail immediately for the West Indies, ... he proceeded to his station with a crew of 150 men; visited almost every island in the West Indies and many of the ports in the Gulf of Mexico; and, notwithstanding the sudden transition from extreme climates, returned to England without the loss of a single man." He also adds "that every precaution was used, by lighting stoves between decks and scrubbing with hot sand, to insure the most thorough dryness. When in command of the 'Recruit' gun-brig, which lay about nine miles from Vera Cruz, the same means preserved the health of the crew when other ships of war anchored around him lost from twenty to fifty men each; and although constant communication was maintained between the 'Recruit' and the other vessels, and all were exposed to the same external disease, no case of sickness occurred on board the 'Recruit.'"

There is but one remedy for this excessive humidity of the air on the decks—*Dryness of the Ship.*

The amount of watery vapor in the air is usually determined by the wet- and dry-bulb thermometers. When the readings of both thermometers are alike the air is saturated with moisture. Unless the air is saturated, the wet-bulb temperature is always above the dew-point, but is below the dry-bulb temperature. All works on meteorology contain the

tables necessary to the determination of those conditions which are dependent upon the indications of the wet- and dry-bulb thermometers.

Ventilation.—The statutes cite that every vessel "carrying 100 or more passengers shall have two ventilators for each apartment occupied by such passengers, one forward and one aft; such ventilators to have capacity proportional to the size of the apartments. If for 200 passengers, such capacity to be equal to a tube 12 inches in diameter, and in proportion for larger or smaller apartments. To rise four feet six inches above the upper deck. If other means to equally well ventilate are on board, this is to be considered as complying with provisions of the statute." The essential object of all ventilation is the maintenance of the air, which fills the allotted cubic space, at such a degree of purity as to keep it free from danger to the health of those who habitually breathe it. Now, the limit of the degree of the impurity of the air, as determined by the amount of CO_2, has been demonstrated, and it has been shown that in vessels this amount is frequently doubled, and in some instances exceeds the limit by six times its range. It has also been demonstrated that the air of vessels generally approaches the limit of its saturation by aqueous vapor from the wetting of the decks, and that when these conditions appear, organic matter—the animal poison of the air—is also increased. In view of the fact that the lungs can only fulfil their function with regard to the blood when they receive a full supply of pure air, one would think that the ventilation of ships would long ago have been an accomplished fact. Yet to-day, as a rule, they are about as much ventilated as an uncorked bottle. The "windsail" is the usual means by which air is expected to be delivered to the lower decks; but, as this contrivance requires constant supervision and is considered to be of very little importance, it receives a very small amount of attention, and is even looked upon in some instances as a source of annoyance. Since the time of Sutton there have been in the naval service many men of the minute mental calibre of Sir John Duckworth, ready to resist any attempt to improve the non-ventilation of vessels. Various methods have been proposed, since that obstinate brewer's time, for the free supply of fresh air to ships, among which may be mentioned those of Edmund, MacDonald, Baker, Williams, Wittig, Kerauden, Villiers, Decaurte, Napier, the "ship's lungs" of Hales, Simon's bellows, Brindejone's fan, De Sauglier's wheel, the automatic system of Thiers and Roddy, etc., etc. The writer believes in the system of extraction, by means of which the air is taken out of the vessel, and he is not aware of any better plan, for its simplicity, performance of all that is required of it, compactness, convenience, and general utility, than that known as the modified Napierian system. By this method every enclosed apartment can be ventilated thoroughly. Its essentials are a reversible blowing-fan, which serves to exhaust the air from a shaft having connections with every space in the vessel. The revolution of such a fan at once changes any column of air from a static to a dynamic condition. Starting with the fact previously stated, that the essential object of all ventilation is the maintenance of the air in the given air-space at a normal degree of

purity, the writer abandons at once, *for vessels*, all calculations for the determination of the allowance per hour of air necessary to fulfil these conditions, believing that such a degree of purity can only be secured in such small spaces by an unlimited supply of pure fresh air, and that the means for securing such supply is a mechanical problem more readily solved for vessels than for dwellings

Disinfection.—The air is the best of disinfectants, but its action in destroying certain of the molecular organic matters by which some diseases are disseminated, demands time. We possess, however, a class of substances which are capable of destroying, in a greater or lesser degree, more rapidly these organic matters. These agents may be said to act in two ways: 1st, by a process of rapid oxidation, which destroys the molecular constitution of the organic matter; and, 2d, by arresting any change in the original composition of this organized material. The first named are *disinfectants* proper; the second are known as *antiseptics*.

Amongst the disinfectants, *chlorine* is the first and most powerful of the agents used to destroy all organic matter prone to decay. It can readily be generated by placing equal parts of chloride of sodium and peroxide of manganese, mixed with water in a basin, and adding an equal quantity of sulphuric acid, or by adding hydrochloric acid to the peroxide of manganese in about the proportion of 1 lb. of the acid to $\frac{1}{4}$ lb. of the oxide of manganese. On steamers, where the red oxide of lead is used for securing joints, the "red lead" may be substituted for the oxide of manganese.

The evolution of *nitrogen dioxide* by the reaction of nitric acid on copper clippings, which, by its affinity for the oxygen of the air, becomes converted into nitrogen tetroxide, gives in this latter agent a very energetic disinfectant, which is considered to be the best adapted of all disinfectants for use during yellow fever. It may be evolved by heating 1 oz. of copper clippings with about 4 oz. of dilute nitric acid. The yield from these quantities is about 421 cubic inches of the gas.

Sulphur also is used as a disinfectant, and is best used placed upon well-ignited coals. The resulting sulphurous acid is a powerful reducing agent. Its action is directly the opposite of that of chlorine, for whilst chlorine exhibits a strong affinity for hydrogen, sulphurous acid has a strong affinity for oxygen, and as hydrogen and oxygen in the proportions to form water are essential to the molecular constitution of organized matter, these agents act by their affinity for those substances.

The so-named *chloride of lime* is efficient from the chlorine which it slowly evolves in the air. On shipboard its elimination may be accelerated by the use of acids; the vinegar from a pickle-cask can be used. When necessary, it is a useful addition to the ordinary whitewash used on shipboard, in quantities readily perceptible to the sense of smell.

Nitrate of lead is said to be a most efficient disinfectant in bilgy ships. The ammonium sulphide sets free the nitric acid, which in turn fixes the ammonia ; the lead sulphide which results being insoluble, remains.

Sulphate of iron, the ordinary commercial copperas, acts very much in

the same manner. It is a cheap and efficient disinfectant. As the ashes from coals contain sulphate of iron, the washings from them might be utilized in case of emergency.

Heat and cold are the natural disinfectants and antiseptics. It is known that a great number of septic organic substances may be preserved indefinitely at or below the freezing-point, but with an elevation of temperature their liability to undergo change is renewed. As an instance of the long-continued "vitality" of septic organized matter, the writer refers to the case of the U. S. S. "Susquehanna," in 1858. Extreme dry heat destroys organic matter. A dry temperature of 140° is known to render vaccine matter inert. A dry heat of 250° F. is the best method of disinfecting clothing and woollen fabrics, for at that temperature it destroys the septic power of organic matter, but does not injure the textures. A boiling weak solution of zinc sulphate should be used in the disinfection of soiled clothing that it may be necessary to preserve.

Impure carbolic acid, with phenyl, cresyl, and other bodies of the series, is a good antiseptic. In fact, all of these substances mentioned as disinfectants and antiseptics are only supplementary agents to cleanliness and air.

SECTION IV.

WATER.

Water is one of the essential conditions of life. It constitutes from two-thirds to three-fourths of the body. The daily quantity of it necessary for the normal performance of the functions depends upon the amount discharged from the body, estimated usually at from 4½ to 5 pounds per person, but subject to numerous variations. This amount, equal to from 72 to 80 fluid ounces, must of necessity be returned to the economy, and is so restored by drink or the water of foods. The allowance of water in the naval service is one gallon for each person daily; for each passenger and sailor in the merchant marine the statute provides three quarts per diem. In steamers provided with a distilling and condensing apparatus for the purpose of furnishing potable water, the allowance is, for drinking purposes, unlimited.

Water is usually carried on shipboard in large iron tanks of from 400 to 600 and more gallons capacity. It was formerly the practice to lime or whitewash the inside of each water-tank, as it became empty, before refilling. This practice, so far as I am aware, has gone out of fashion. It should never be permitted. It has been observed by Medlock, that water containing organic matter, after passing through iron pipes, has the organic matter materially diminished. The action of the metal is an oxidizing one, converting the nitrogen in the organic matter into nitrous

acid, and in this manner breaking up the affinities of the carbon, hydrogen, and oxygen. The same observer remarks that, by allowing water to remain in contact with a coil of iron wire for twelve hours, all traces of organic matter are removed, or it is converted from a soluble into an insoluble state, and in this condition is capable of being removed by ordinary filtration. In vessels without distilling apparatus it becomes necessary to fill up the tanks with water from shore. In every case the sources of this supply should be investigated, and the water examined for organic or inorganic impurities. In the naval service this examination is limited to organic matter, chlorides, lime, and hardness.

The tests for organic matters are the potassium permanganate, chloride of gold, and the Nessler test. Of the latter test the writer has already given his opinion as to its value for quantitative estimation. The of potassium permanganate test fails to demonstrate the presence of the fatty substances, urea, creatin, sugar, gelatine, hippuric acid, and starch. The chloride of gold, when boiled with neutral or faintly acid waters free from nitrites, gives a color and precipitate, if organic matter is present, varying, according to the quantity of oxidizable matter, from a rosy pink to violet, olive-colored, or a dark olive or black precipitate.

If the chlorides are present in any decided quantity, their presence, other things considered, furnishes good evidence of contamination from the liquid excreta of men and animals. The quantitative estimation of the chlorides is readily made by treating a known quantity of the water to be examined, to which has been added a few drops of a solution of neutral potassium chromate, by a standard solution of nitrate of silver until a permanent red tint appears.

Lime is recognized by testing with a solution of oxalate of ammonia.

Hardness is determined by Clark's soap-test.

A rough method of testing is to evaporate to dryness a quantity of ordinary potable water in a spoon over a spirit-lamp, and in another spoon the same quantity of the water to be examined, and then to compare the residues. Both spoons should next be heated to redness, and the degree of charring of the residues should be noted. The more solid the residue, and the greater the degree of charring, the greater the amount of impurities.

Filtration, after the water has stood for a certain time, generally removes all the insoluble and suspended matters. The choice of a filter seems to be of some importance.

Considering the action of animal charcoal, and in a lesser degree wood charcoal, and the previously mentioned action of iron, a filter composed of clean iron-turnings, mixed with pounded and coarse charcoal, so as to form rather a compact mass, is the best for all such uses. It has the merit of economy and efficiency.

The *aëration* of distilled water on shipboard is usually left to take care of itself. It is easily accomplished by letting the water fall in a state of fine subdivision from a height through the air, or allowing it to flow over previously well-washed pebbles packed in some receptacle and

open to a continuous current of air. Some of the patent apparatuses supplied to vessels furnish the distilled water perfectly aërated.

All suspected waters should be boiled, allowed to cool, and filtered before they are used for drinking purposes.

SECTION V.

FOOD.

In the alimentation of masses of men subjected to exposure and frequently called upon to perform great bodily labor, the question of food is of vital importance. More especially is this the case in the naval and merchant marine, where the greater or lesser collection of men resembles a machine to which a certain quantity of material must be supplied in order to produce the requisite amount of force at the moment such force is called upon to be delivered. Viewed in this manner, all foods represent stored-up force, and their function consists in the development and manifestation of it in molecular and muscular changes and movements. Foods have been defined as articles composed of or containing elements in a form which enables them to be used for the nourishment of the body, either by being themselves appropriated by the organsm, by influencing favorably the process of nutrition, or by retarding disassimilation.

The quantity of carbonaceous and nitrogenized substances existing in a dry state in any food has been adopted by all physiologists as the measure of the tissue-forming and heat-making values of all foods, and upon the proportions of each of these elements in a food all dietaries for hospitals, etc., as well as the rations for the army and navy, have been constructed. Dalton's experiments demonstrate that about 2.41 lbs. av. of solid food and 3.38 lbs. av. of liquid food are required in 24 hours by a man in full health and exercising in the open air. It is evident, however, that the demand for food, as well as the quantity and character necessary to sustain the system at its normal condition, depends upon habit, climate and temperature, age, sex, occupation, personal peculiarities, condition of the muscular apparatus, etc. Variety in the character of food is also an essential in alimentation. It is a well-known fact that the strict adherence to one or more articles of diet, in time, becomes distasteful, and, if persisted in, such foods are not digested nor assimilated, but develop in the individuals so subjected a scorbutic condition. The introduction of preserved meats, vegetables, and fruits into the ration has made it possible to secure considerable variety in alimentation on shipboard, but these preserved foods are at best but partial substitutes for fresh provisions. The writer would call attention to the views of Dr. Joseph Wilson, U.S.N., in regard to this subject, especially as regards the vegetable

parts of preserved foods. It is known that, if the ordinary bean of the navy ration will not sprout when immersed in warm water for some hours, it is unfit for food. Dr. Wilson associates this fitness or unfitness with the power of germination, growth, or vitality, and the writer would apply this suggestion to other preserved vegetables prepared in like manner. The subject of the slow chemical and physical changes which take place in preserved foods of all varieties and prepared by different methods, needs a more thorough and extended investigation.

The navy ration established by law is as follows:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the navy ration shall consist of the following daily allowance of provisions to each person : One pound of salt pork, with half a pint of beans or peas ; or one pound of salt beef, with half a pound of flour, and two ounces of dried apples, or other dried fruit; or three-quarters of a pound of preserved meat, with half a pound of rice, two ounces of butter, and one ounce of desiccated "mixed vegetables;" or three-quarters of a pound of preserved meat, two ounces of butter, and two ounces of desiccated potato; together with fourteen ounces of biscuit, one-quarter of an ounce of tea, or one ounce of coffee or cocoa, and two ounces of sugar, and of a weekly allowance of half a pound of pickles, half a pint of molasses, and half a pint of vinegar.

SEC. 2. *And be it further enacted*, That fresh or preserved meat may be substituted for salt beef or pork, and vegetables for the other articles usually issued with the salted meats; allowing one and a quarter pounds of fresh or three-quarters of a pound of preserved meat for one pound of salted beef or pork; and regulating the quantity of vegetables so as to equal the value of the articles for which they may be substituted.

SEC. 3. *And be it further enacted*, That should it be necessary to vary the above-described daily allowance, it shall be lawful to substitute one pound of soft bread, or one pound of flour, or half a pound of rice, for fourteen ounces of biscuit; half a pound of rice for half a pint of beans or peas; half a pint of beans or peas for half a pound of rice.

SEC. 4. *And be it further enacted*, That, in case of necessity, the daily allowance of provisions may be diminished or varied by the discretion of the senior officer present in command ; *provided*, That an additional ration of tea or coffee and sugar be hereafter allowed to each seaman, to be provided at his first "turning out." That in addition to the navy ration, as now established by law, the apprentice boys in the naval service who are attached to training-vessels shall be allowed four ounces of oatmeal and four ounces of hominy, coarse or fine, on alternate days, together with one-half of a gill of molasses.

Table I. presents the component parts of the navy ration for each day in the week, and does not include the addition to the ration as established for apprentice boys in the service.

The Revised Statutes (Sec. 4260) direct for each passenger in the merchant marine as follows :

20 lbs. of good navy bread, 15 lbs. rice, 15 lbs. of oatmeal, 10 lbs. wheat flour, 15 lbs. of peas or beans, 20 lbs. of potatoes, 1 pint vinegar, 60 gallons of fresh water, 10 lbs. salted pork, 10 lbs. of salt beef, free of

bone, all to be of good quality. One-tenth of such provisions to be issued weekly, and at least three quarts of water daily. Sec. 4564 provides: "For every vessel bound across the Atlantic, belonging to a citizen of the United States, to have on board, well secured under deck, 60 gallons of water, 100 lbs. salted flesh meat, 100 lbs. wholesome ship-bread for every person, and in like proportion for longer or shorter voyages." It is directed also that the scale of provisions, as in Table II., be allowed and served out to the crew during the voyage.

TABLE I.

	Biscuit.	Beef.	Pork.	Preserved Meat.	Flour.	Rice	Dried Fruit.	Pickles.	Sugar.	Either— Tea.	Either— Coffee or Cocoa.	Butter.	Dried Potato.	Beans.	Molasses.	Vinegar.
	OZ.	POUNDS.					OUNCES.							FRACTION OF PINT.		
Sunday	14	...	..	¾	..	½	..	...	4	½	2	2	2	...	...	...
Monday	14	...	1	...	...	...	...	...	4	½	2	...	...	½	...	...
Tuesday	14	1	...	...	½	...	2	...	4	½	2	...	...	...	...	...
Wednesday	14	...	1	...	...	...	...	4	4	½	2	...	...	½	...	...
Thursday	14	...	...	¾	...	...	...	...	4	½	2	2	2	...	½	...
Friday	14	1	...	...	½	...	2	...	4	½	2	..	...	...	...	...
Saturday	14	...	1	...	...	...	...	4	4	½	2	...	...	½	...	½
Weekly quantity	98	2	3	1½	1	½	4	8	28	3½	14	4	4	1½	½	½

TABLE II.

	Bread, Lbs.	Beef, Lbs.	Pork, Lbs.	Flour, Lbs.	Peas, Pts.	Rice, Pts.	Barley, Pts.	Tea, Oz.	Coffee, Oz.	Sugar, Oz.	Water. Quarts.
Sunday	1	1½	..	½	..	..	..	⅛	½	2	3
Monday	1	..	1¼	..	½	..	..	⅛	½	2	3
Tuesday	1	1½	..	½	..	..	..	⅛	½	2	3
Wednesday	1	..	1¼	..	½	..	..	⅛	½	2	3
Thursday	1	1½	..	½	..	..	..	⅛	½	2	3
Friday	1	..	1¼	..	½	..	..	⅛	½	2	3
Saturday	1	1½	..	..	..	..	..	⅛	½	2	3

Substitutes.

One ounce of coffee, or cocoa, or chocolate may be substituted for one ounce of tea, molasses for sugar—the quantity to be one-half more ; one pound of potatoes or yams, one-half pound of flour or rice, one-third pint of peas or one-quarter pint of barley, may be substituted for each other. When fresh meat is issued, the proportion is to be two pounds per man per day in lieu of salt meat. Flour, rice and peas, beef and pork may be

substituted for each other; and, for potatoes, onions may be substituted. It is also directed (Sec. 4262), that "such provisions are to be well and properly cooked, and served out at stated and regular hours by messes, or in such manner as shall be deemed best and most conducive to the health and comfort of the passengers;" and Sec. 4258 directs that there should be "For fifty passengers one caboose or cooking-range, and increased in size in proportion as the number of passengers is greater or less."

The antiseptic power of salt has been known from the remotest times, but no satisfactory explanation of its mode of action has as yet been given. The salting of meat diminishes very much its nutritive value. When raw meat is salted, the liquid portion speedily begins to ooze out and dissolve the salt, forming what is known as brine—a saturated solution of salt with meat-juice. Meat thus treated loses quite a large proportion of its albumen, as well as its sapid and saline constituents; but at the same time it loses its tendency to putrefy. This brine containing the meat-juice can be utilized, in case of necessity, by placing it in a buckskin or sheepskin bag, and immersing it first in salt water—which causes the salt to diffuse itself, leaving the meat-juices—and then in fresh water. A little attention to the densities of the solutions determines the point of time at which immersion should no longer be continued. This dialyzed meat extract mixed with flour may serve in an emergency to sustain and prolong life. Salt meat can be freshened in like manner.

Within a few years, in addition to the usually hermetically-sealed meats, etc., the writer has seen "corned beef" put up in the above manner. It is quite palatable, and has a high nutritive value. It contains about 60 per cent. of solid matter, of which 40 are albuminates, 15 fats, and 5 salts—over 6 per cent. of nitrogen. A half-pound per diem would be an ample allowance, if it ever should become part of the navy ration.

On board of naval vessels, within late years, the means of baking bread have been supplied. It has been proposed, however, to supply both the naval and merchant marine with hermetically sealed tins of bread. In addition to other merits, convenience of stowage and the increased quantity that can be carried are great advantages. Cheese, also, is now packed in air-tight tins, and would be an invaluable addition to the ration. This method of packing ends any objections to the old method of supply. Butter, also, may be obtained packed in like manner, and keeps indefinitely. It has also been packed in waxed canvas bags, 50 lbs. in each bag, and kept in casks filled with salt water, which should be renewed weekly. Butter thus preserved has been known to remain fresh and sweet for three years in a tropical climate. It is a question worthy of careful consideration, whether the allowance of pork may not be diminished, and butter and cheese increased in the ration. The writer has noticed a method which is employed by the whalers in the North Pacific Ocean for preserving potatoes on long voyages. The potatoes are to be cleaned, pared, cut into small cubes, placed in a hogshead, and then covered completely with a dense black sugar-house molasses. When taken out, washed, and cut, each mass will be found to have become dis-

colored externally to a depth of a line or so, but the taste and texture of the tuber remain. Dried peas furnish a very valuable addition to the ration.

The chemical effects of *cooking* upon food deserve some mention here. Beef is said to lose by boiling one-fourth of its original weight, and by roasting, one-third. Roasting consists in the gradual coagulation of the albumen by heat transmitted from the surface to the interior. The effects of boiling are of two kinds: 1st. If the meat to be cooked is plunged into boiling water, the operation resembles roasting in this, that the albumen of the surface of the meat is sooner coagulated, thus preventing the escape of the meat-juices from the interior. Meat thus treated is said to preserve its full flavor. 2d. If the meat is placed in cold water, and slowly heated, the albumen, salts, and flavoring elements of the meat gradually pass out, the water gaining in nutritive qualities and flavor, which the meat loses. This is the preferable means of making soups.

In the naval service all the component parts of the ration are subjected to inspection and tests before reception and issue, and, in case of question as to adulteration or decay, a survey with careful examination is at once had. No such inspection or tests apply to the food of the merchant sailor. If such were the case, we should no longer have such disgraceful records as that of the "Leibnitz," in 1867, at New York: "The rations were scanty and bad, often rotten; the butter rancid, the beans and sauer-kraut thrown overboard by the hungry, and the supply of water to people sweltering in insufferable heat and indescribable nastiness, was only half a pint a day. *Only* 108 deaths out of 544 were laid to the charge of all this neglect and cruelty;" or that of the "Empire," which arrived at San Francisco in 1875, with scurvy, when "the provisions were tainted, and eaten with difficulty." There is abundance of legislation, but not the first step is taken towards enforcement of the law in regard to the provisions to be carried on shipboard. The writer has carefully compared the tissue-building and heat-forming quantities of the foods, and is of the opinion that the navy ration would be the more nutritive one for the merchant marine, and that, as the Government has already all the means for the inspection of foods, the ration for the merchant service should be the same, and subject to a like inspection as that of the naval establishment.

In respect to the hours for meals, in the naval service the usual hour for breakfast is about 8 o'clock A.M.; then follows an interval of 4 hours, or at 12, noon, dinner; then an interval of 5 hours, when supper is served; and again an interval of from 12 to 15 hours, during which time the men are asleep and without food. When the cyclical changes that occur physiologically in the economy are considered, this latter interval should be terminated not with the "additional ration of tea or coffee and sugar," on first "turning out," but by—and I use a sailor phrase—"a hot square meal." For as respiration, circulation, and consequently calorification, all have their minima in the morning watch, it becomes a matter of sanitary

importance to avert this depressed condition by food, and not to add to the normal lowered strength by work on an empty stomach.

The following tables represent the histogenetic and thermogenetic values of the principal parts of the navy ration:

AT SEA.

ARTICLES.	Weekly quantity in oz.	Water.	Albuminates.	Carbohydrates.	Fats.	Salts.
Meat preserved	24	12.96	6.624	...	3.708	.708
Beef (salt)	32	15.715	8.16	Extractives 1.05	.0576	6.742
Pork (salt)	48	...	4.224	....	35.184	....
Biscuit	98	7.84	15.288	71.932	1.274	1.666
Flour	16	2.4	1.76	11.248	.32	.272
Beans	19.5	3.12	4.3875	9.7305	.39	.468
Rice	8	.8	.4	6.656	.064	.04
Potatoes desiccated*	4	....	.24	3.744	.016	.016
Butter	4	.24	.012	....	3.64	.108
Sugar	28	.84	....	27.02	....	.14
Total	281.5	43.915	41.1015	131.3805	44.6536	10.304
Daily average	40.214	6.2735	5.8716	18.7686	6.397	1.472

Daily average water-free food, 32.4912 oz. av.

IN PORT.

ARTICLES.	Weekly quantity in oz.	Water.	Albuminates.	Carbohydrates.	Fats.	Salts.
Beef (salt)	32	15.715	8.166	Extractives 1 05	.0576	6.742
Beef (fresh)	80	48.	9.6	....	5.376	1.024
Pork (salt)	16	....	1.408	....	11.728	....
Bread (wheat)	112	44.8	8.96	55.104	1.68	1.456
Flour	16	2.4	1.76	11.248	.32	.272
Beans	6.5	1.04	1.4625	3 2435	.13	.156
Rice	8	.8	.4	6.656	.064	.04
Potatoes desiccated*	4	....	.24	3.744	.016	.16
Butter	4	.24	.012	....	3.64	.108
Sugar	28	.84	....	27.02	....	.140
Total	306.5	113.835	32.0085	108.0655	23.0116	10.098
Daily average	43.875	16.262	4.5726	15.4379	3.28737	1.4425

Daily average water-free food, 24.7403 oz. av.

* Taken as equal to 16 oz. of fresh potatoes.

Average at sea and in port of daily water-free food in grains:

Albuminates	2284.687
Carbo-hydrates	7482.687
Fats	2114.537
Salts	637.562
Total	12519.473

Grains of carbon and nitrogen in the daily water-free food:

	Carbon.	Nitrogen.
At sea	7217.575	405.143
In port	5199.587	315.512
Average	6208.581	360.228

By a comparison of these amounts of carbon and nitrogen, as measuring the chemical and physical values of foods, it will be observed that the naval ration is amply sufficient for all demands that may be made upon it under varying circumstances.

SECTION VI.

CLOTHING.

The consideration of the hygienic value of clothing embraces the examination of all fabrics used as coverings for the body, as to their permeability to air, hygroscopic qualities, the power of the material and texture to conduct heat, their power of absorbing luminous heat-rays, as well as their weight, when manufactured for use, in relation to the work of the body expended in their carriage. In man, from numerous observations, the normal temperature of the body is given as 98.4° F., and in repose he gives off from the skin and lungs about two pounds of water per diem, which is increased to as much as four pounds when he is at work. These facts in relation to the surrounding air present an experiment in physics, viz., that of a warm, humid body plunged into a cooler fluid. This body is subject to physical laws, and is cooled by conduction, radiation, and evaporation. The rate of this cooling depends on the temperature and humidity of the air. The sanitary object of clothing is to keep the heat which radiates from the body longer in contact with its surface. Clothing becomes necessarily heated by this radiation and conduction, and is cooled in like manner, but the rate of cooling depends upon its texture and volume. Woollen fabrics are the principal ones from which the clothing of the sailor is manufactured, and they have become so from their permeabil-

ity to air, their bad conducting heat-power, and hygroscopic qualities. We could not wear garments that did not permit of the constant access of air to the surface of the body. Of the hygroscopic properties of our clothing in relation to the excretion of water from the skin, we have very little experimental information. Experiments upon the heat-conducting power of the textures and materials used for clothing are but few; those of Pettenkofer, Coulier, and Hammond are the only ones of value in their relation to hygiene. Cotton and silk are better conductors of heat than wool. If the conducting power of linen is taken at 100, that of wool may be from 50 to 70. According to Pettenkofer, flannel is more permeable to air than linen in the proportions of 100 to 58. It is also, according to the same observer, more hygroscopic in the following proportions:

Flannel....... 174	Linen....... 75	Maximum.
" 111	" 41	Minimum.

Texture has nothing to do with protection from solar-heat waves, but the color heightens the absorption of luminous heat. Thus, according to Krieger, if a white fabric absorbs in the proportion of 100, black absorbs 208, and blue almost as much as black. Traditionally, blue has become the color of the sailor's clothing. Gray is the better color in a military as well as hygienic point of view; it absorbs but few of the luminous heat-rays, and for every twelve men in red hit in battle, there are seven in green and five in gray. In the merchant marine it is directed by statute that every vessel is to be provided with at least one suit of woollen clothing for each seaman. The naval outfit is as follows:

One Pea-jacket.
Two Flannel Overshirts.
Two Woollen Undershirts.
Two pairs of Woollen Drawers.
Two pairs Woollen Socks.
One pair Blue Satinet Trowsers.
One Seamless Cap.
One pair of Calfskin Shoes.
One pair Blankets.
One Mattress.
One Black Silk Handkerchief.

To this should be added the cummer-band or cholera-belt. Fashion has in some measure dictated the shape of the sailor's dress. The naval cap for officers and that for the men are about the sorriest travesties on good sense, as sanitary head-dresses, as could well be conceived. There is no better head-dress than the Glengarry, as it is called, for sailors, and the modified form of the Spanish cap for officers leaves little to be desired in the way of ornament, as well as comfort. The weight of the sailor's cap in our navy averages 6.5 oz. av. Shoes are now made of good quality, and more in conformity to the hygiene of the feet. A broad sole and a

broad heel, not more than $1\frac{1}{4}$ in. in height, are now part of the regulations regarding boots and shoes. Men should never be allowed to go barefooted, even in hot weather. The pantaloons should be made with a broad waist-band and laced in the back. The practice of allowing a narrow leather strap to be worn to support the clothing should not be permitted, as it compresses the viscera of the abdomen, very much as if a cord were drawn tightly around the body. In regard to the bedding, each man should use his own bed. The watch on deck should carry down their own hammocks, and those turning out should lash, carry and stow their own. Besides being a disgusting and filthy practice, that of allowing men going off watch to turn into the hot, moist beds of their shipmates, reeking with their exuviæ, it is not conducive to health, as can be readily understood. Dry clothes should be allowed the crew after a wet tour of duty. Clothing should be inspected *thoroughly* once a month, instead of the make-believe inspections so pretentiously made at present; when washed it should be put away in the bags *dry*. Bedding should be aired as frequently as fair weather will permit. In the struggle for existence one of man's defensive weapons is clothing, and relatively to the life of the sailor the most important point with regard to his clothing is to guard against moisture, either hot or cold.

In the naval service it has become necessary to have certain standards for the quality of the fabrics used for clothing. These are based on the microscopic appearance of the fibres of the material, their behavior with certain chemical reagents, weight, number of threads to the square inch, tensile strength, character of the dye in colored fabrics, etc.

Microscopic Appearances.

Wool.—The fibres are cylindrical collections of numerous cells, and present each the appearance of a tube covered with epidermic scales which overlap each other. The zigzag markings are characteristic.

Cotton.—The fibres of cotton appear to be made up of flat ribbon-shaped cells, thicker at the edges than in the middle; they are irregularly twisted, with a broad longitudinal cavity more or less well defined. There is frequently a kind of net-work striation apparent on the surface.

Linen.—Each thread is made up of longitudinal, rounded, unmarked fibres with a narrow longitudinal cavity; surface generally smooth; diameter of the fibre not uniform; they taper towards the end and terminate in a blunt point.

Silk.—The fibre is cylindrical, smooth, without organic structure or longitudinal cavity, of uniform thickness, and presents here and there on both sides a kind of narrow margin.

Chemical Tests.

To distinguish cotton from wool.—Wash, dry and weigh a square inch of the fabric, then boil in a solution of caustic soda or potassa (specific gravity 1040). The whole of the wool will be dissolved whilst the cotton fibres remain almost unchanged. Collect the cotton, wash,

dry, and again weigh. The difference is the loss in wool. The relative proportions by weight can then readily be determined. If the number of threads to the square inch have previously been counted, their relative proportion also may be estimated.

To distinguish cotton from linen.—Boil a square inch in water to remove the stiffening, dry and weigh, then immerse in strong sulphuric acid for *two* minutes; remove from the acid, wash thoroughly, and boil in water to remove the gummy substance produced by the action of the acid on the cotton; again remove, wash, dry, and weigh. The loss is the cotton. If the threads have been previously counted, their relative proportion can be determined.

Silk.—Wash, dry and weigh a known quantity of the fabric. Boil it in a saturated solution of zinc chloride. Silk is dissolved. It is also dissolved by a mixture of equal parts of sulphuric and nitric acids, but the fabric should not remain immersed longer than twenty minutes. An ammoniacal solution of copper dissolves silk and cotton; after a longer time, linen. Wool is caused to swell but slightly by it. In a mixed fabric of wool, cotton and silk, the estimation of each may be made in the following manner: wash, dry and weigh a known weight of the fabric; boil in a strong solution of zinc chloride; collect, wash, dry, and again weigh—the loss is silk; boil the remainder in a solution of caustic soda or potassa, collect the residue, wash, dry, and again weigh—the loss is wool; collect the residue, wash, dry and weigh—the weight equals the cotton and loss.

Physical Characters.

It is directed in the naval service that the cloth for *pea and monkey jackets* shall be all wool, shall weigh 26 ounces to the yard, shall be 54 inches in width, shall have 64 threads in the warp and 44 in the filling to the square inch, and shall have a tensile strength of 62 lbs. to the warp and 42 lbs. to the filling. Any cloth breaking under a strain which falls short of the standard by more than four pounds, is to be rejected. A variation of three pounds in the tensile strength is allowed.

The cloth for *trowsers* is to be all wool, is to weigh 21 ounces to the yard, is to be 54 inches wide, and is to have 56 threads in the filling and 60 in the chain to the square inch, with a tensile strength of 68 lbs. to the warp and 50 lbs. to the filling in a strip one inch wide of each. The cloth for *caps* is to be all wool, is to weigh 17 ounces to the yard, is to be 54 inches wide, is to contain 64 × 64 threads to the square inch, and is to have a tensile strength of 28 lbs. to the warp and 24 lbs. to the filling per strip 4 inches long and 1 inch wide. *Blue flannel* is directed to be not less than 5½ ounces in weight to the yard, to be 27 inches wide, and to have 48 × 48 threads to the square inch, with a tensile strength of not less than 35 lbs. to the warp and 25 lbs. to the filling in a strip 4 inches long and 1 inch wide. *Thin flannel* is to weigh 2.36 oz. per yard, is to be 27 inches wide, is to have 48 × 48 threads to the

square inch, and is to have a tensile strength of 12 lbs. to the warp and 9 lbs. to the filling in a strip 1 inch wide and 4 inches long.

Sheeting is to be made from pure flax thread free from cotton, is to weigh 12.31 ounces to the yard, is to have 64 × 64 threads to the square inch, is to be 80 inches wide, and is to have a tensile strength of 62 lbs. to the warp and 52 lbs. to the filling per strip 1 inch wide and 8 inches long. *Canvas-duck* is to be free from cotton, is to weigh 8.23 ounces per yard, is to be 27 inches wide, is to contain 40 × 36 threads to the square inch, and is to have a tensile strength of 193 lbs. to the warp and 119 lbs. to the filling per strip 1 inch wide and 8 inches long. *Cotton-duck* is to be 28.5 inches wide, is to contain 44 × 36 threads to the square inch, and is to have a tensile strength of 140 lbs. to the warp and 132 lbs. to the filling per strip 1 inch wide and 4 inches long. *Socks* are to be woollen, knit or woven, 14 inches in the leg, and of an average weight of 4 oz. avoir. per pair. *Blankets* are to be of wool, are to weigh 6.5 lbs. per pair, are to be 58 inches wide and 78 in. long each, and are to contain 20 × 20 threads to the square inch. *Neck-handkerchiefs* are to be of black silk, are to be 31.5 × 31.5 inches in size, are to contain 14 × 23 threads to $\frac{1}{8}$ of an inch square, are to weigh 10 or 12 grains troy, and are to be free from lead or sizing. *Boots and shoes* are to be made of oak-tanned leather, hand-made, with broad soles, and heels from 1 inch to $1\frac{1}{4}$ inch high.

Dyes.

The regulations call for one color in the fabrics, viz., blue, and direct that it shall be a pure indigo. To detect indigo-dyed fabrics, a sample of the material should be macerated in fuming sulphuric acid. The dense blue liquid (sulphindigotic acid) can be tested by nitric or chromic acid, etc., for indigo. Or, immerse a sample of the fabric in a saturated solution of chloride of lime. If dyed of pure indigo, the color will be discharged. If the fabric be steeped in a solution of caustic soda, the color will remain unchanged if pure indigo has been used as a dye. Prussian-blue dyes are unchanged by a solution of chloride of lime, and the color is discharged in a solution of caustic soda.

Weight of Clothing.

The average weight of the usual clothing of the sailor is about 9 lbs. The total weight of suit, with overcoat, cap, and shoes, is about 13 lbs. 8 oz., as an average of numerous observations.

SECTION VII.

LIGHT.

Of the influence of light in the production of derangements of health, we possess very little information. Light is known to promote development and nutrition, and has some unknown effect in hæmatosis. It is difficult, perhaps impossible, to separate the influence of light from heat in physiological researches in this direction. The deprivation of light, or its deficiency, predisposes to inactivity and sleep. It also predisposes to scrofula, and in sedentary occupations with impure air is a cause of atonic dyspepsia. The condition known as anæmia in man seems to be analogous to the etiolation or blanching in plants produced by the exclusion of light; but this latter condition in vegetables is associated with other causes. One hygienic application is of great importance in this connection, namely, that prisoners on shipboard should never be deprived of sunlight.

SECTION VIII.

SLEEP.

The organic processes which are the inseparable associations of the ordinary activities of the mind, render the brain after a time incapable of supporting its continued psychical function, and thus sleep is induced. This exhaustion of the brain is equivalent to fatigue in the muscular system, and as prolonged muscular exertion requires rest, so sleep is the rest of the brain. Indeed, the law of fatigue applies markedly in this instance, for the longer the brain continues its activity, the more slowly does it act, and the less capable does it become of performing the ordinary mental functions, so that, in some cases, sensations have not been perceived, although the impressions of external stimuli were constant. Damiens slept upon the rack, and the powder-boys at the battle of the Nile fell asleep midst the noise and confusion of the action. Forbes Winslow cites the case of a Chinese felon who was condemned to death by deprivation of sleep. The torture terminated on the nineteenth day.

The causes of sleep depend upon external as well as internal actions. Thus, sleep generally occurs at night, while the excitement of light, combined with many other causes, tends to keep us awake during the day. Prolonged exposure to heat or cold also induces sleep; the same is true of debility, exhaustion, and muscular fatigue. These same causes also deter-

mine in a measure the quantity and duration of sleep. Sleep ceases as soon as the susceptibility of the brain for those organic acts which are exhibited by cerebration, etc., is restored. Thus, in the morning the functional activity of the brain is more active, and declines during the day. Functional activity in a measure determines the amount of sleep required; to this, however, must be added the influences of age, temperament, and habit. The young require more sleep than the aged; those in whom organic life is active require more than those in whom functional activity is slow; the adult requires eight hours of sleep. In these two relations, it will be observed, sleep is to be considered with regard to marine hygiene. Ordinarily, the crew of a vessel is divided into two watches, one-half being grouped in the starboard watch, and the other half in the port watch, with similar duties for each. The usual tour of duty at sea, at night, commences at 8 P.M., when one watch remains on deck and the other turns in, only to turn out at midnight to keep the mid-watch, that lasts from 12 M. to 4 A.M.; those who are on deck from 8 to 12 "turn in" now, to "turn out" at 4 A.M., when the mid-watch turns in again to rest until about daylight, when "all hands" are called. On the succeeding day this is in a measure reversed: those who had the mid-watch of the previous night go on duty at 8 P.M. It will be noticed that, at the most, six hours is the full extent of the duration of sleep permitted; but it occurs far more frequently that from four to five hours comprises the time allowed. A man-of-war's man undergoing the work which he is habitually called upon to perform, and which consists of exercises and drills, requires at least eight hours of sleep, and a full allowance should be given apprentices. These facts have led such writers as Turnbull and Blane to advocate strongly the division of ships' companies into three watches. Turnbull gives a cogent reason for such division: "In order than men may suffer less from a tainted atmosphere, by reason of the close situation in which they sleep, it has been thought preferable to put men in three watches." Blane thus expresses himself: "It would be well if it could be rendered convenient at all times, except in cases of danger or emergency, to put men in three watches, instead of watch and watch. By the former arrangement they have eight hours sleep and rest, by the latter only four hours, which is not sufficient for refreshment" . . . . All these reasons remain in force at the present day.

The hammock.—The bed of the sailor is known to us by a modification of its Indian name, first mentioned by Columbus in the account of his earliest voyage to America. It is a hanging bed, usually made of heavy canvas-duck, in some instances of hemp, and is about six feet long and three feet wide. Eyelets are worked in at each extremity through which the nettles of the clews are fastened; an iron ring in each clew and a lashing complete this bit of sailor furniture. It usually contains the mattress with blankets, quilts, and such articles as the sailor does not care to stow away in his ditty-box or -bag.

Bedding should be aired at sea or in port whenever wind and weather permit, and the hammocks should be scrubbed and dried on an average

about once in every two weeks, clean hammocks being served out at each change, for the purposes of health and cleanliness.

In this sagging bag, curved as a bow, suspended from the hammock-hooks, the sailor sleeps. As the body thus reposes in an unnatural position, there is a tendency to congestion of the abdominal and pelvic viscera; consequently this bent position during sleep is objectionable from physiological and hygienic considerations. Prone on Mother Earth her children sleep stretched out at full length; on the waters her seafaring sons repose inversely bent, as if in remembrance of "the bow set in the clouds," which marked the ending of a memorable cruise.

Few improvements have been made in this necessary luxury, save to adapt it in a measure to the purposes of a life-saving apparatus. A hammock that will secure sleep to the sailor in a horizontal plane rather than in a curve, and that will fulfil the requirements of lightness and small bulk, is still a thing to be desired in all navies.

SECTION IX.

DISCIPLINE.

Section 4263 of the Revised Statutes of the United States directs that the master of the vessel is to maintain good discipline and such habits of cleanliness among the passengers as will tend to the preservation and promotion of health. He is also to keep the apartments clean and healthy, to have a water-closet for the exclusive use of passengers, to have the bedding aired, and to disinfect with chloride of lime.

The relation of discipline to the health of the sailor involves at once his medico-legal status. Since the promulgation of the earliest maritime code, in the reign of Edward III. (1327)—"The Blacke booke of the Admiralty," which appears to have been founded upon the "Rolle of Olayron," written in the 11th or 12th century—to the present time, the discipline of the naval and merchant services has found its expression in that refuge for all the criminal brutality that occurs on shipboard—"the usages and customs of the sea-service."

Infractions of discipline which are punished by law with such means as affect the physiological functions are, in the naval service, "solitary confinement on bread and water for five days;" "solitary confinement not exceeding ten days;" "solitary confinement not exceeding thirty days in irons, single or double, on bread and water or on diminished rations;" "solitary confinement in irons, single or double, not exceeding thirty days." Considering that such solitary confinement is to be in a cell which is "not less than 6½ feet long and 3½ feet broad, with the full height between decks," but which is to be "properly ventilated;" that the amount and quality of the food are not sufficient, as has been

demonstrated by experiment and observation, for the maintenance of the ordinary wear of the body; and that such confinement is accompanied with the deprivation of sunlight, the writer is firmly convinced that such punishment should be materially changed, if not altogether abolished. The urgency for such a change becomes the more apparent if we also bear in mind that the sailor thus punished is, at the expiration of his sentence, remanded to his usual duties when in a condition which is in a degree analogous to, if not identical with, the convalescence from a wasting disease. The time has passed when morality was supposed to be inculcated by the tails of a "cat," and it is not to be expected that a respect for the law that treats him in the manner indicated will be increased in the sailor by a diet of nothing. The writer does not claim to be possessed, as Burke remarks of Howard, of "a morbid sympathy with scoundrels," but the official records of excessive punishments seriously affecting the health and well-being of sailors, for trivial offences, for the furious mania of a rum-poisoned sailor, for that want of precision which is only attained by prigs, and of punishments inflicted under no warrant of law for alleged inefficiency, etc., certainly appeal to him in the maxim of Terence:

> "Homo sum: humani nihil a me alienum puto."

To use the words of Roche: "Poor Jack is sadly in want of moral and physical improvement; not necessarily a helpless object for sympathetic gush and ill-directed philanthropy, nor particularly in need of 'fostering influences' or benevolent counsels, but a human being, with rights as well as duties, with wrongs not to be redressed by tracts alone, and vices which, having survived ages of corporeal, may possibly be amenable to moral discipline." The death of a sick "beach-comber" on board the "Salacia," from exposure and ill-treatment, begging, as the brutal mate kicked him whilst crawling to the hatchway, "Mercy, for God's sake;" the mutiny of the "Borden;" the roasting alive of a stowaway in the fire-room of a Pacific steamer; the cases made known officially in the general orders of the navy department, and others not so officially promulgated—these are in no manner extraordinary occurrences, even at the present time. The subjects of this unreasonable maritime discipline usually find their way, if living, for care and treatment, to the naval and marine hospitals.

This maritime law reads, "maintain good discipline," leaving it to the master of the vessel to define the word "good," and to a second mate to evolve out of his inner consciousness what is meant by "discipline." Its maintenance is usually effected by means of steel knuckles, belaying-pins, and the bullet.

There is much of legislation for the punishment of crimes committed by seamen, but very little for the amelioration of their condition, or their elevation and advancement. The coarseness of the task and the harshness of the task-master have helped to brutalize this human being. It is

within the writer's experience to have heard officers of the navy regret that the barbarism of flogging had been abolished by statute; those who expressed such a regret, however, were endowed with mental perceptions which were incapable of distinguishing the difference between moral courage and brute force; or else, recognizing the absolute despotic power which they possessed, believed that, in Dogberrian logic, "argal," they must use it.

Discipline, as it affects the well-being of the sailor, demands a more thorough investigation than has here been limned. Of the relation of the sick-rate to the rates of punishment on shipboard, the writer has a few absolute data—not enough at present, however, for a proper discussion or for a generalization.

The ordinary exercises on shipboard are of a character which expose men to much fatigue; yet men must be kept busy—no laziness nor excessive work. Everything should be done to promote cheerfulness, and all exercises should be within moderate bounds. The sewing- and mending-days should never be encroached upon; no interference should be permitted with the regular meal hours; every indulgence not incompatible with a military discipline should be permitted, for humanity and indulgence under such circumstances go hand in hand.

The writer, at the risk of being considered ungallant, offers a word upon the presence of women on shipboard. Nothing but dire necessity should ever place a lady on a vessel of war. The practice of permitting the wives of commanding officers to accompany them on national vessels should be arrested by law. They have no more right there than has the wife of the humblest sailor on board, and their presence has caused more bickering, discontent, and *dis-ease* than the harshest discipline which the writer has ever known. The extra work imposed is not at all compensated for by their presence. Since the loss of one of the English iron-clad fleet with a part of her crew, in consequence, indirectly, of this cause, it is stated that the wives of officers are not permitted to accompany them on shipboard. The sooner such sources of discontent are removed the better. Women themselves would be the first to arrest this condition of affairs could they know the specializations with which they are characterized by the crew. A true respect for the sex should never remove them from their exalted position or subject them to the shadow of a cloud.

The writer believes in a thorough and rigid discipline — the hand of iron in the velvet glove,—but he does not believe in brutality. Punishments have been divided into three classes:

1. *Capital*, where the death of the offender is intended to deter others from similar offences.

2. *Precautionary*, where the offending person is removed from society by imprisonment.

3. *Correctional*, where some pain or penalty is inflicted, so as to deter from future crime.

These punishments should be executed promptly, severely, and with efficacy; they should be administered, however, deliberately and advisedly; and precautionary and correctional punishments should not be of such a character as may either directly or indirectly permanently affect the health of the individual. "Confinement in a low, damp, unwholesome room, not allowing the common conveniences which the decencies of nature require, but by which the habits of the constitution are so affected as to produce a distemper of which the prisoner dies," is felonious homicide, according to English statute. It is proposed as a sanitary measure that all power of punishment should be removed from one man's hands. "No person," says an eminent jurist, "ought to be entrusted with the execution of any sentence who has been personally offended by the crime committed. For this reason the commanding officer, who has a direct personal interest in the preservation of discipline, and therefore may entertain angry feelings towards offenders, is not the most proper person to superintend the execution of punishments." For every offence a summary board of officers should be summoned, and after a fair and impartial examination, they should adjust the punishment to the sentence. This has already been directed in the naval service in a measure, and a medical officer, after examining the sentence, gives his reasons for assent or dissent upon physiological grounds solely.

The writer finds it difficult to close this section on discipline with calmness, as he recalls the tyrannous abuse of despotic power which has found its shelter under that name. He proffers this advice to any one thinking of entering either of the services, and quotes the words of an older officer to a young relative thinking of enlisting: "It's a good idea —a good idea; but you don't know how much trouble you'd save yourself by committing *suicide* first, and not afterward."

SECTION X.

STATISTICS.

The importance of any statistical information depends upon the exact value of the numerical units of the same nature, and so comparable with one another as to admit of their aggregation and classification. The advantages possessed by the naval medical officer in this respect are very great. He has at his hands the physical history of every man in the crew; the exact locality and the environment he can observe and register with instruments of precision; the day and hour of the invasion of disease can be made out almost with exactness; and he has eliminated from his data many of the questionable matters which under other circumstances tend to obscure the value of such deductions as he may make. Accuracy of diagnosis is expected from, and truthfulness of registration is demanded of him, for all medical statistical facts should be marked by their mathemati-

cal accuracy. The medical officer should be able to give readily the loss of service per man in a given force from sickness during the year, the number of days of sickness attributable to each man for any required disease, etc. All such facts have their bearing in determining the causes of sickness and death of seamen on various stations and under the influence of different climates, and become provocative of investigation as to the nature of these causes as well as with regard to the means for their removal or prevention. When once the numerical units have been classified and grouped together, these groups may be compared with each other or with the aggregate of numerical units. The relation existing between these groups is made evident by recourse to arithmetical proportion, which affords a constant numerical standard in percentages or in multiples of a percentage.

Parkes, speaking of army medical returns, observes: "It cannot be too strongly urged on medical officers, that perfect acurracy of diagnosis is a duty of the highest kind. It is much better to have a large heading of undetermined diseases, than, when in doubt, to put a case of disease under a heading to which it has no unequivocal pretensions." After the necessary ratios in regard to any grouping have been obtained, the graphic method of representing statistical results may be adopted. Various plans have been used to delineate such results. Lines of various lengths compared with the standard, curves with varying radii, etc., have been used, and, if colored, serve to fix the attention more readily than would groups of figures.

SECTION XI.

DISEASES.

Section 4569 of the Revised Statutes reads thus: "Every vessel of over 75 tons, bound on a deep-sea voyage, to have a chest of medicines. If bound across the Atlantic or Pacific, around Cape Horn or Cape of Good Hope, engaged in whale or seal fisheries, she shall be provided with a sufficient quantity of lime- or lemon-juice, and also sugar and vinegar or other antiscorbutic, to be served out to every seaman as follows: within ten days after salt provisions have been served out, the lime- or lemon-juice and sugar at the rate of one-half ounce per day, and vinegar one half-pint weekly, for each member of the crew." The necessity for the above directions does not need any explanation from the writer, other than to state that it is an evidence of a tendency on the part of the law-makers towards the prophylaxis of disease—in this instance scorbutus or scurvy.

The use of lemon-juice in scurvy appears to date from about 1564, when some Dutch sailors, suffering from this affection, ate the oranges

and lemons of which the cargo was composed, and finding themselves relieved from that condition, made haste to communicate their mode of relief. In 1593, Sir Richard Hawkins experienced the antiscorbutic efficacy of lemon-juice in his crew; but the credit of its introduction as a prophylactic against scurvy greatly rests on the book of John Woodall, Master in Surgery, published in London in 1636. Since then the use of lime- or lemon-juice, as directed in the statute, has become the common property of all maritime nations.

The sailor and the ship are likewise carriers of the causes of disease. Thus, relapsing fever was brought to Philadelphia in 1844 by emigrant vessels from Ireland. The germs of cholera have also been carried by vessels and crews. The recent outbreak of cholera in Japan was excited by its introduction from China, and the transportation of the disease from one port to another in that empire was by vessels. It is suggested that on an outbreak of cholera on shipboard, it is advisable to separate at once all who have any diarrhœal trouble, from the well, to collect *all* the dejecta in vessels containing a strong solution of copperas or sulphate of iron, to allow no water to be drank except that which has been boiled, and to dry and ventilate the vessel and apartments as much as possible.

Small-pox has been frequently carried by vessels and crews. In such cases, isolate the sick, place them aft, and shelter them by screens; at the same time keep the vessel heading to windward, or "on a wind." Vaccinate and revaccinate all who may be exposed; and the writer would not hesitate, considering his own experience, as a last resort, to inoculate the whole crew.

Typhus fever—essentially, as one of its synonyms implies, a disease of ships—is a disease of overcrowding, a disease arising from animal filth, and one which is a disgrace to our present sanitary legislation. The writer has no hesitation in saying that the dismissal of any commanding officer would be the mildest of punishments if a case of idiopathic typhus fever should occur on board of a ship under his control; and if the disease arise on an emigrant vessel, the captain and mates should be imprisoned for confining the sailors or passengers on such overcrowded, ill-ventilated, filthy decks as give rise to this disease.

Yellow fever is peculiarly a disease of ships—that is to say, its origin is not directly on shipboard, but ships that are in such a condition as we have already described, with their human contaminations and septic conditions, present opportunities peculiarly fitted for the growth, development, and spread of the germs of yellow fever. The opinion founded upon the observations of the yellow fever epidemic at Rio de Janeiro, in 1850, was that it originated from decaying organic animal matter. It was also observed that the general mortality, the mortality from yellow fever, and the relative humidity of the air fluctuated together, and that with a high relative humidity the death-rate was also high. The average opinion of medical officers of the navy who have observed yellow fever, and experienced an epidemic visitation, may be briefly stated as follows: In addition to the causes of *malarial* fevers originating from *vegetable* de-

composition, there is superadded a *miasmatic* poison from *animal* decomposition—a fæcal poison. An eminent member of my own corps thus tersely, but significantly, puts the conditions: "Crowd filthy, half-fed emigrants in a filthy, unventilated ship, to cross the North Atlantic—what follows? Ship fever—genuine typhus. Try the experiment in a tropical river, and you get typhus icterodes." It has elsewhere been stated how cleanliness and dryness have been the means of preventing the invasion of yellow fever on shipboard. When once yellow fever germs find a lodgment on shipboard, the difficulties in the way of their destruction are almost insurmountable. As an evidence of this the writer again refers more fully to a "yellow fever ship," as she is known in the service, the U. S. S. "Susquehanna." In 1858 a severe epidemic of yellow fever occurred on board this vessel at Greytown, C. A. Yellow fever was unknown at Greytown, and the vessel had arrived directly from the Mediterranean with a perfectly healthy crew. When the epidemic appeared the "Susquehanna" put to sea, bound northward, but the extent of the epidemic forced her to put in at Kingston to secure men to work the ship. Nearly one hundred cases were landed and placed in the hospital, and Dr. F. Rose, R.N., who volunteered his services, proceeded with the rest of the crew to New York. On her arrival nearly one hundred more cases were landed at the Quarantine Hospital. Previous to this cruise the "Susquehanna" had suffered from yellow fever, but in the interval had been exposed to some two or three winters in the North. It must be patent that the poison of the fever remained quiescent, only awaiting favoring conditions to germinate. As usual, when the bilges came to be examined, they were found to be foul. This experience was duplicated in the same vessel, for, after being again exposed to several winters, thoroughly fumigated and disinfected, and again being commissioned, on her return to the tropics another epidemic appeared on board. Extreme cold does not destroy these germs, but preserves them until a fitting temperature, moist air, and other congenial conditions favor their restoration to activity and growth.

The great number of diseases of the integumentary system which occur amongst sailors arises, as the writer is disposed to believe, from the overcrowding and consequent impure air, which contains animal organic matter. The experiments of Richardson (J. G.) have demonstrated that minute organic matter can find its way into the blood through the respiratory channels, and the observations of Orth lend credence to the view that such minute organic masses of micrococci or fungous spores may give origin to abscesses, carbuncles, and boils.

As two-thirds of all the pulmonary diseases on shore arise from vitiated air, the rule holds good on shipboard in a much greater degree. Cold and damp furnish to the sick-returns the acute, subacute, and chronic rheumatisms, and sequent heart disease.

The increase in diseases of the digestive, nervous, and circulatory apparatus and systems among firemen on shipboard has arisen since the introduction of steam as a motor for ships. Insolation and heat-exhaus-

tion occur frequently on shipboard, especially on steamers. According to Naylor, a cloudy day with a moist air favors its occurrence.

The great foes of the sailor are impure air and moist air. The medical history of any ship may be written if these two factors only are given. The limits of these pages would not contain the names of authors—omitting even the details of facts that bear upon these points—who have demonstrated the truth of this assertion, viz., that "a damp ship is an unhealthy ship."

The transportation of venereal diseases and their sequent propagation by sailors is a matter of history. Its spread in the New World through the instrumentality of the navigators of the fourteenth century, and its introduction into the islands of the Pacific, date from the arrival of the discoverers. It has with the inhabitants of these islands become the source of their national decay. In the discussion of the mode of propagation of this disease and the preventive measures deemed necessary, too much of the "high moral element" and the like unmitigated bosh has been interjected by the reverend element in the community. Venereal affections are diseases, and require to be studied in their physiological relations primarily, rather than in their moral aspects. The normal man, upon becoming affected by this poison, presents to the pathologist subjects of study in every tissue of the body.

More than that, its lethal influence is seen in the modifications of both structure and function in descent, and in the increased death-rates of such as are affected by hereditary transmission. No one is free from the dangers of its loathsomeness; the healthy and the robust may become affected; the physically strong, the mentally energetic, are alike exposed to its prematurely decaying influences. These diseases are no more social evils than small-pox or scarlet fever, and they should be dealt with in like manner by sanitary legislation. Their prevention may be expected with the Millennium—not before,—but their restriction is much within the power of the law-makers. It has been stated that such restrictive measures as would prevent its propagation would seriously interfere with the so-called "liberty of the individual." The sale of poisons is restricted by law, and it does not materially affect this liberty; the right to carry on an avocation destructive to the life and health of one's neighbor is also limited; and how much more should this, which diminishes the well-being not only of individuals, but also of communities and nations? It is known from observation that about one-fourth of the diseases of seamen are venereal in character, and this number would no doubt be increased, were all the cases known, for there are many that escape scrutiny. It should be made part of the duty of all medical officers of the navy to examine men going on shore on liberty, to discover if they are affected with any venereal affections likely to be propagated, and to place them under medical care. Elsewhere in this chapter the writer has alluded to the necessity for the physical examination of seamen for the merchant marine. If for nothing else, this examination should be made for the purpose of detecting any of these diseases, and, upon their discovery, of subjecting

the sick man to medical observation and treatment. The necessity for such inspection of sailors, in order to find out those who are affected with primary lesions, and then to prevent them from propagating these diseases, needs no argument from the writer; it appears to him to be self-evident, axiomatic, and he can find no words too trenchant or too sledge-hammer-like in cogency wherewith to drive home his convictions with regard to this truth.

Hospitals in the merchant marine, according to the statute (Sec. 4254), shall not occupy more than 100 superficial feet of deck or platform. The sick-bay or hospital on naval vessels is located forward on the berth-deck. Human devilishness could hardly have suggested a more unfit place for the treatment of the sick or wounded. It should be removed to amidships in single-decked vessels, and in double-decked vessels the topgallant forecastle should be prepared for the sick-bay. The diseases most frequent and prevalent at sea have this advantage, that they are more the subjects of prevention than most others, because they depend upon remote causes that are assignable, and which increase or diminish according to certain circumstances, which are in a great measure within our power.

Fragments.

A word in regard to anchorages in unhealthy localities. Anchor as far from marshes as possible, or give plenty of water between the ship and shore, if necessity compels an anchorage to leeward of a marsh. Blane cites an instance where a hundred yards in a roadstead made a difference in the health of the crew of a ship at anchor, by her being under the lee of a marsh in one situation and not in another.

The subject of the ventilation and dryness of vessels carrying grain, fruits, and other perishable articles, as well as cargoes of hides, guano, coal oil, sugar, molasses, coffee, etc., is one of financial interest alike to owner and merchant. It is certain that dryness tends to the preservation of perishable cargoes, and that ventilation also tends to lessen the active decay that occurs in hot closed holds. To secure such ventilation to cargoes, but for no other general use, the writer is of the opinion that the system, known as the "automatic tubular ship-rudder," is especially adapted.

Turnbull's five cardinal directions for all vessels were: 1st. To keep dry. 2d. To keep clean. 3d. To avoid cold and fatigue. 4th. To keep warm in winter; and 5th. To keep regular discipline.

The writer, before he pipes "Belay" to this chapter, which has occupied his few spare hours granted from official duty, desires to close with a quotation from Sir Gilbert Blane, to which he heartily assents, for Blane desired and asked that they might become part of public instructions, and not be left to the so-called discretion of the commanding officer, and he calls such a regulation "a legal necessity."

"I hardly ever knew a ship's company become sickly which was well

regulated in point of cleanliness and dryness. It is the custom in some ships to divide the crew into squads or divisions, under the inspection of respective officers, who make a weekly review of their persons and clothing, and are answerable for the cleanliness and regularity of their several allotments. This ought to be an indispensable duty in ships of two or three decks ; and when it has been practised, and at the same time ventilation, cleanliness and dryness below and between decks have been attended to, I have never known seamen more unhealthy than other men. The neglect of such attentions is a never-failing cause of sickness."

BIBLIOGRAPHY.

Armstrong's Naval Hygiene. 1858.
Admiralty Instructions for Transports.
Blanc's Dissertations, 3 ed. 1803.
British Merchant Shipping Act.
Clarke on Long Voyages. 1792.
Cutbush's Observations on Seamen. 1808.
Fonssagrive's Hygiène Navale. 1877.
Gihon : Naval Hygiene. 1873.
Instructions for Govt. Med. Officers U. S. Navy. 1878.
Lévy : Hygiène Militaire. 1862.
Lind : Hot Climates. 1821.
Mahé : Hygiène Navale. 1874.
Marine Hospital Service Reports. 1873, 1874, 1875, 1876.
Plimsoll : Our Seamen. 1873.
Ruschenberger : Medical Topography, etc., Rio de Janeiro. 1855.
Sanitary Reports Bur. Med. and Surgery. 1872, 1873, 1874.
Statistical Report Health B. Navy. 1839 et seq.
Turnbull : Naval Surgeon. 1806.
Wilson, J. : Naval Hygiene. 1878.
Welch, F. H. : Alexander P. Essay. 1870.

HYGIENE OF COAL-MINES.

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HYGIENE OF COAL-MINES.

Perhaps the best introduction to a discussion of the hygiene of mines is a sketch of the work, habits, and mode of life of the party chiefly affected by it—the working miner. It is premised that the word "mine" in this paper is used in its ordinary sense, as referring to a subterranean excavation, of greater or less extent, and that though substantially the same class of hygienic conditions is to be found in all mines, the ones considered in this paper are those especially pertaining to coal-mines.

The working miner, then, usually devotes his whole life to that occupation. He frequently, perhaps generally, begins at the age of from eight to twelve years as a "slate-picker" in the breaker—the building in which the coal is prepared for market—where his business is to sit all day, with twenty or thirty companions of about his own age, and pick out fragments of slate from a thin stream of coal constantly flowing past him. The place in which he works is apt to be more or less open and exposed to draughts. His clothing consists of shirt and pantaloons, usually old and ragged; a battered cap and a pair of coarse shoes—the last often omitted in summer. His whole costume, whatever its original color, is soon stained a uniform black by the thick cloud of coal-dust which fills the breaker, filters through his clothing and begrimes his skin, and which forms a large component part of the atmosphere he breathes. As boy and man, his invariable practice at the close of every working day is to wash himself thoroughly from head to foot, a custom to which his hardiness and generally rugged health in early life are to be largely attributed. His diet, as boy and man, is simple. Pork, salt fish, potatoes, and home-made bread are its staple constituents; but when work is good and money sufficient, all the luxuries of the local market are to be found on the miner's table. He learns to smoke and chew tobacco at an early age, has few or no scruples against

the use of either malt or alcoholic liquors, and withal grows up to be a lusty, sinewy youth, who seldom troubles the doctors, unless overtaken by one of the numerous accidents to which his own recklessness not less than his somewhat dangerous occupation exposes him. At the age of eighteen or twenty, if he has not previously entered the mine as a driver, or for some other description of boys' work, he goes in as a "laborer," becoming in effect, though not in name, an apprentice to a practical miner, with duties so nearly the same as those of his "boss," that, for the purposes of this article, they may be considered identical.

The miner gets to his work shortly before seven o'clock in the morning, if on the "day shift," or between five and six in the evening, if on the "night shift." He is dressed in flannel shirt, woollen or heavy duck pantaloons, heavy shoes or boots, and usually with a coat thrown loosely over his shoulders. On his head he wears a cap, a slouch hat, or a helmet shaped like a fireman's, but of smaller dimensions. Whatever the head-gear, his lamp, a small tin one shaped like a miniature coffee-pot, swings by a hook over the visor; unless the place in which he works is "fiery," when he carries a safety-lamp in his hand. His dinner-can and canteen of water or cold tea are swung from a strap passing over his shoulders. Thus equipped he rides down the shaft or the slope, and, if he is lucky enough to catch a train of empty mine-wagons going to his working-place, he "rides in," a distance, it may be, of two or three miles from the foot of the shaft. If no wagons are at hand, he walks, most of the way through water and slush, taking small account of wet feet, or indeed of wet clothing at any time, though the roof over him may drip all day long. It is an exceptional case if he wears a rubber or oil-cloth suit, even in the wettest places.

Two miners, or two miners and a laborer, form a gang, and their work is an alternation of exhausting physical labor and intervals of rest. They work with drilling-bar, powder, and pick, getting down the coal and breaking it to a size small enough to handle; with drills, preparing and charging a hole for blasting; with shovels, clearing away the coal and getting it into the mine-cars to be sent to the surface; and then, when a particular job is done, or a blast is to be fired, they repair to the nearest place of safety, and in their overheated condition sit down in the cold, damp draught of the ventilating current to cool off as rapidly as possible. Is it any wonder that rheumatism, consumption, and "miner's asthma," are the common ailments among them? In walking to and from his work along the mine gangway, the miner tries to step on the sills on which the track is laid, thus avoiding the hollows worn by the mules' feet between the sills; and as these are laid from two and a half to three and a half feet apart, the effort gives him a long, slow, swinging gait, the head being thrown forward to counterbalance the body. The same posture is found best for traversing the "manways" and other smaller passages, the long stride being advantageous in picking the way over rough and uncertain ground, while the bent head escapes projections of the roof, and permits the light of the lamp in the miner's cap to fall on the ground at his feet. The habit

becomes fixed, and the old miner may always be known by his bent shoulders and swinging stride. That this unnatural compression of the chest cannot but be injurious is evident.

Among the most laborious of the miner's duties is setting the timbers which support the roof. The gangway, or general passage-way of the mine, is usually from seven to ten feet in height, and about the same in width, seldom falling below these dimensions in American mines, where thick beds of coal are worked and the cars are drawn by mule or locomotive power, though in the thin beds of England and Wales, they are often so small that a man cannot stand upright in them. "The gangway timbers," unless the rock and coal are unusually solid, consist of a prop on each side, with a cross-piece uniting them. They are from 10 to 15 inches thick, of length adapted to the dimensions of the gangway, and being of green wood, are correspondingly heavy, weighing from 300 to 500 pounds, according to size. Yet three men are expected not only to set the side-pieces, but to lift the heavy cross-beam into position far above their heads, and fix it there. The work is so hard, performed as it is beyond the "brattice" which supplies fresh air, in an atmosphere more or less charged with powder-smoke and carbonic acid gas, that, by the time it is done, all three are thoroughly exhausted and overheated, and in most favorable condition for the reception of colds, lung disorders, and rheumatism. If working in a steeply pitching "breast,"[1] though the timbers used are not so large, they are quite large enough to tax the strength of the two men who have to get them up a steep and difficult "manway" by sheer lifting and pulling. In this way, which is almost like working up through a chimney, timbers averaging perhaps eight feet long by six inches thick are carried to the top of the "breast," which may be from sixty to eighty yards above the gangway level.

Mention has been made of the "brattice." This is a highly important aid to the ventilation of the mine. It is an air-tight partition, generally carried along one side of the gangway, though sometimes over its top, and so arranged with reference to the ventilating current, that the fresh air is carried along one side of it, while the impure air, which is to be withdrawn, passes along the other. Its object is to keep up a circulation of air in the recess formed by advancing operations at the "face" of the workings. As every passage or chamber is pushed forward into the solid coal or rock, it necessarily forms a bay, in which the air is always stagnant, unless moved by some such appliance as the "brattice." Communicating passages, called "headings," are made between the working-chambers, about thirty yards apart, for the same purpose; but as the chamber is opened beyond the "heading," a "brattice" becomes neces-

[1] In steeply pitching breasts of great thickness—say, like the Mammoth Vein in Pennsylvania—timbers are not used, but the miner works the coal on benches, and works from the top rock downward, having his breast constantly full of coal, on which he stands. In coal-beds of ordinary thickness, say, ten feet and less, these timbers are used.

sary here also. One great cause of impurity in the atmosphere in which the miner works is that the brattice is frequently neglected, and the work pushed so far beyond it that it ceases almost entirely to affect the air at the "face," which then becomes loaded with powder-smoke and carbonic acid, or, in fiery mines, carburetted hydrogen. In either case the effect on the miner's health is most injurious.

Of course the principal occupation of the coal-miner is cutting and getting out coal, and here again his work is performed under disadvantageous circumstances as regards the preservation of health. Much of it consists in lying on the side, "holing under" the mass in a low cut, where every stroke of the pick dislodges a fresh shower of dust, to be inhaled by the miner. Other portions consist of straining at arm's length to dislodge a mass hanging from the roof, of lifting and tugging at heavy weights, of shovelling continuously, hour after hour (where coal has to be shovelled into the mine-cars, the filling of from eight to ten cars, holding three tons each, is considered a day's work for a laborer), and of swinging a heavy sledge in drilling by hand-power. His footing is frequently unsteady, having to be maintained on a steeply pitching floor of smooth slate, so that, as a miner once expressed it to a friend of the writer, "it is very much like asking a man to stand on the roof of a house while working." There are chasms under foot and loose rocks overhead, equally to be avoided, and the whole shrouded in a darkness which the miner's lamp reduces only to a semi-obscurity, and which hides without removing the danger.

The miner's life when not at work also has its effect on his general health, and, as with every other class of men, this varies according to the tastes and temperament of the individual. His house is of frame, plainly but conveniently built, and furnished with the necessary conveniences of life. Being situated in the country, and in a section where land is of little value for either building or agricultural purposes, there is plenty of space about the house, and fresh air in abundance. Even the close neighborhood of frequent hog-pens and occasional stables, and the universal practice of emptying slops from the house on the ground at the back door, have little or no deleterious effect, being neutralized by the abundance of pure air with which their odors and gases mingle.

The miner's first care on coming from work is to take a tub-bath, cleansing his skin thoroughly. He then dresses in a clean suit, eats his supper, and is ready for the duties and amusements of the evening, both of which are few and simple. Usually the male inhabitants of the "patch" gather in groups in the open air, in the village store, or in the omnipresent saloon, and smoke and talk, until the coming of an early bed-time sends them home. Comparatively little drinking is indulged in except on pay-day, which comes once a month, and is celebrated by the drinking classes with a "spree." In this particular the miner's nationality makes itself seen. While men of all nations may be found drinking to intoxication, the practice as a race is confined to the Irish. There are few of American descent among the miners, and these are generally found

among the best and steadiest of their class. The Irish are the most numerous, and they are fond of liquor, drink to excess, and are very quarrelsome when drunk. Terrible fights often accompany a pay-day spree among them. Next to the Irish, in numbers, are the Welsh, a temperate, thrifty and intelligent race, who form a valuable element in the population. They are industrious and economical, generally succeed in securing homes of their own, which they delight in beautifying and keeping in order, and are apt to be found in positions of trust and authority in later life. Germans and Poles, too, are industrious and economical, but less intelligent and less temperate than the Welsh, more careless in their personal habits, and utterly regardless of the laws of health. They eat unwholesome food, sleep in ill-ventilated rooms, and early acquire a sallow, unhealthy appearance. Nevertheless, their active occupation and the enforced cleanliness of the "shifting-suit" counteract many of the ill effects of their mode of living, and they will probably be found to average as long lives as the other races. Less numerous, though making up the bulk of the population in certain localities, are Scotch, English, and Italian miners. The last are much like the Irish in habits, while the others hold an intermediate place between them and the Welsh. It is of course to be understood that these remarks apply in general to the nationalities; there are very good workmen and excellent citizens in all classes, and, similarly, there are worthless characters in all; but the general tendency will be found as has been stated. As in every other occupation, personal habits have their effect on the constitution, and predispose it to invite or to repel disease. Thus, drunkenness causes gray tuberculosis, which, with the inhalation of dust and noxious gases, predisposes to consumption, a very common disease in mining towns.

One of the most prominent conditions of a miner's working life—certainly the first to be noticed by the casual visitor—is the absence of sunlight, a very deleterious condition as many physicians and engineers of large practical experience consider it, while others as positively deny that it has any injurious effect. Dr. J. T. Carpenter, of Pottsville, in a paper read before the Schuylkill County Medical Society, says (Transactions Med. Soc. of Pennsylvania, 1868–9, p. 488): "The deprivation of sunlight must be a very strongly predisposing cause of disease. It is to be expected that the results of this deprivation will become apparent in general anæmia, in chronic nervous irritations, in tendencies (easily to be developed by exciting causes) toward scrofula, tubercular phthisis, and allied maladies." Other practitioners, however, assert that the deprivation of sunlight is among the least of the miners' afflictions; that no injurious effects from it are perceptible, and that no acute disease can be traced either wholly or in part to this cause; while physicians will probably continue to differ forever as to whether or not absence from sunlight during all the working hours predisposes to or prolongs any chronic complaint. In this connection it must be borne in mind that the miners' work is carried on wholly by artificial light, and that usually of a very poor quality. Not the faintest ray of sunlight can penetrate to him, and

about the first thing the unaccustomed visitor usually remarks is that it so *very* dark. It needs but a slight exercise of the imagination to persuade him that he has at last found a sample of that "thick darkness that might be felt" which once visited the land of Egypt.

In the winter season, especially when the mines are working "full time," their inmates, as a rule, see but little of the sun during their working days. They enter the mine before sunrise, and quit it after sunset. It is, however, a very common practice among them to work "week about," one week by day and the next week by night. In this case they have at least from four to six hours of every day's daylight during their night week, and in any case they usually spend Sunday above ground. They do not complain of want of sunshine, and it is difficult to trace any ill effects of its absence upon them. Their complexions are pale, but not more so than those of persons who work at night, or in shaded rooms above ground; and their eyesight, as a general thing, considering the miserable light they have to work by, is remarkably good. Few miners are compelled to wear eye-glasses, for either working or reading, before reaching old age.

But though the deprivation of sunlight may be a matter of dispute, so far as the actinic effect is concerned, there can be no question that the quality of the light by which the miner works has a most important bearing on the subject of his liability to accidental injury or death. The best light that has yet been devised for his use is the common tin lamp above described, fed with fish-oil, or with a mixture of whale and coal-oils. This lamp yields a light about equal in practical use to that of three sperm candles, and when carried on the miner's head gives him all the light he needs in traversing the galleries of the mine, its elevated position showing him every projection of the low roof, and every piece of loose coal or rock that may threaten him, while at the same time his eyes are shielded from its glare, and his hands are left free to work or carry his tools. In his working-places, however, and especially in the immense chambers so frequently met with in the Pennsylvania anthracite mines, it is very different. Where the thicker beds of coal are worked, or where the rock partition between the workings in one bed and those in a superincumbent one has been broken through, it is not uncommon to find chambers 30 feet wide by 100 feet long (occasionally even doubling these dimensions), with a ceiling 30, 40, or, in extreme cases, 60 feet or more in height. Two or at most three miners' lamps are expected to illuminate so much of this immense space as to enable the miners working in it to see whether the effects of blasting or the natural working of the strata have loosened any pieces of rock or coal, which are likely to come tumbling down upon them, as well as to make all secure, and to prosecute their work of dislodging and getting out the coal to the best advantage. It is true that the above description applies only to chambers which are nearly worked out, in "flat-pitching" beds of great thickness, and that in the majority of cases miners are enabled to keep their work within narrower limits than these; but it is also true that hundreds of men work in just

such situations as are here described, and whatever advantage may be derived from ability to keep close to their work is too often counterbalanced by the use of safety-lamps, which are made necessary by the presence of explosive gas, and which give a light scarcely equal to one-tenth that of the naked lamp.

In some mines, where the coal-beds lie horizontally or at a low angle with the horizon, there is room to accumulate waste matter, and many tons of rock, slate, refuse coal, decaying wood, and all the waste material of the mine, are thrown in heaps called "the gob;" and in bituminous and semi-bituminous mines, where the coal is soft and disposed to generate heat, the "gob" frequently raises the temperature of the surrounding workings, and occasionally even reaches the point of spontaneous combustion. In steeply pitching mines this is not the case, as then all the contents of the chambers gravitate to the gangway, and the "gob" must be carried out with the coal. Where "gob" accumulates, however, where the iron pyrites commonly found in coal are decomposed by the action of water, and where decomposing organic matter contributes its quota of heat, the temperature is raised, and if the air-current is sluggish, that portion of the mine may become oppressively hot. The heat thus generated produces a gas which English miners call "stythe," very injurious to the health of the workingmen. If now the miner, after working in this heated atmosphere, exposes himself unguardedly to the cooler air of the gangways, or places himself in the draught of the ventilating current, he runs the same risk which exposure to similar conditions would involve on the surface of the earth—no more and no less. The careful miner protects himself by putting on the coat which he has thrown aside while at work, before he reaches the gangway. The careless one takes the risk and the consequences.

The gases found in coal-mines give rise to a class of evils peculiar to the business, and most fatal in their consequences. They are the miner's most deadly and most insidious foe, and, unless guarded against by thorough ventilation, his most dangerous one. Disease contracted by exposure, or sudden death from the fall of tons of rock and coal, is too often due to the fault of the sufferer himself, and the consequences of his folly generally fall upon himself alone; his fellow-workmen are not involved in the destruction which overtakes the too careless or too venturesome individual; but not so with the gases. A single ignorant, drunken, or reckless miner may in a moment fire the charge that shall hurl a hundred into eternity; nor do the fatal consequences of the rash act cease with the flame and shock of the explosion; the "after-damp" is even more deadly than the fire-damp, and often carries death not only to those who have survived the explosion, but to the brave bands of rescuers who are always ready to rush to the assistance of the sufferers before the atmosphere of the mine has been restored to a condition fit to sustain life.

R. C. Taylor (Statistics of Coal, p. 99, ed. 1855) gives the following table of mine-gases and their relative specific gravity:

	Sp. gr.
Carburetted hydrogen ("fire-damp")	0.558
Azote or nitrogen gas	0.976
Atmospheric air	1.000
Sulphuretted hydrogen	1.191
Carbonic acid gas ("choke-damp")	1.524
Arsenical and mercurial vapors (not determined).	

Hon. Andrew Roy, State Mine Inspector of Ohio (Third Ann. Rep., p. 87, 1876) says:

"The noxious and poisonous gases of mines are fire-damp (light carburetted hydrogen gas), black-damp (carbonic acid gas), white-damp (carbonic oxide gas), and sulphuretted hydrogen gas, also called white-damp by the miners." These are all noxious gases and not to be trifled with; but by far the most important are fire-damp and black-damp, the latter also called "after-damp" (though not correctly so in a strict sense) because it, mingled with nitrogen and steam, invariably follows an explosion of fire-damp. Carburetted hydrogen is one of the most common gases of nature. It is the marsh-gas which rises from the decomposing vegetable matter in swamps, and forms the "will o' the wisp" of the belated wanderer. It abounds in certain rocks, and is very abundant in the carboniferous strata; but its most conspicuous display is to be seen in the enormously productive "gas-wells" of the Pennsylvania oil-region, where millions of cubic feet are daily given off. There is comparatively little of it in American mines as yet, but more will probably be found as the mines go deeper. It is more abundant in bituminous than in anthracite coal, and in deep workings than in shallow ones. None of the American bituminous mines, though fatal explosions have occurred there, have as yet penetrated far enough to set this gas free in the dangerous quantities which have so often made fiery furnaces of the English mines; and though a number of fatal explosions have occurred in the deeper-worked anthracite pits, they have been limited in character and are growing rarer year by year as the science of mining is more fully understood and the art of ventilation more carefully applied.

The common name of this gas, "fire-damp," is doubtless derived from its observed phenomena. Mixed with common air in the proportion of one part of carburetted hydrogen to seven or eight of air, it becomes violently explosive, filling the chambers and galleries in which it ignites with an intensely hot flame, accompanied by an enormous expansion of the gas and followed by an equally violent contraction—or, more correctly speaking, by a vacuum which the surrounding atmosphere rushes in to fill. Its chemical effects are the direct production of the vapors of water and carbonic acid, and the separation of azote or nitrogen. (Taylor, p. 102.)

At an inquiry into the cause of a disastrous explosion in Lancashire, England, in October, 1877, where the knowledge and experience of the best engineers and mine inspectors in England were consulted, it was found that carburetted hydrogen will not explode unless mixed with at least six

times its bulk of atmospheric air, nor when diluted with fourteen times its bulk of air; its greatest explosive force is when combined in the proportion of one part of gas to from seven to ten of air. When this mixture is fired it suddenly expands to 1,700 times its former volume, or, if confined, exerts a pressure of 200 pounds to the square inch, while the temperature rises to 1500° Fahrenheit. The sudden and violent expansion drives before it all the atmospheric air which is not consumed, and leaves the workings filled with a compound of

Nitrogen	Eight parts.
Carbonic acid gas	Two "
Watery vapor (steam)	One part.

a mixture fatal to all kinds of life. In less violent explosions a portion of atmospheric air may remain and mingle with the after-damp, in which case there is less danger of immediate asphyxia to those who may be in the workings. At the same inquest it was found that a safety-lamp may not be moved through an explosive mixture at a greater speed than eight feet a second, as at a higher rate the flame of the lamp will be forced through the gauze meshes which protect it. The explosion in question was thought to have been caused by a boy carrying a safety-lamp at a rate of five feet a second against an air-current heavily loaded with gas, which was moving at the rate of eight feet per second. The direction taken by an explosion of fire-damp is always contrary to that of the ventilating current; that is, it travels toward the downcast shaft, and in this way it frequently reverses the current, causing the downcast shaft to become the upcast, and *vice versâ*. This is probably caused by the fact that the supply of oxygen which feeds the flame comes in with the air-current, and is followed back toward its source. Mr. Dickinson, Government Inspector of Coal-Mines in England, testified before a parliamentary committee of inquiry in 1853, that pure fire-damp is neither inflammable nor respirable; two men in his district had been suffocated by inhaling a strong admixture of it. The effect was to quicken the pulse; he had tried his own pulse before going into a mixture of fire-damp; it beat 78; after breathing the vitiated air for a few minutes the pulsations ran up to 84; he tried a manager's pulse, and found it ran up from 80 to 84; he tried a fireman's pulse, it was at the unusual height of 120, and ran up to 126; the gas in which these experiments were tried was so pure that it could only be fired at the edges, where it came in contact with air, and a person could live in it only a few minutes. In this connection the following practical experience, related by Edward Herbert, of St. Clair, Pennsylvania, an old practical miner, is of great value. Mr. Herbert was asked if he had ever been "blown up" by a fire-damp explosion. He replied: "Oh yes, a few times, but I never was hurt much;" and then gave the following as his experience with mine-explosions: "I have oc-occasionally gone into fire-damp (carburetted hydrogen) so pure that it could not explode except at the edges, where it mixed with the air. I

never went far, and I never stayed long, and I always shut my eyes and held my breath until I came out again—just went in a little way to get my tools, or something like that. When I happen to be in an explosion, my practice is to shut my eyes, hold my breath, and try to get as near the floor of the mine as possible. Men are often so scared when they see the fire flash, that they open their mouths and holler; then they inhale the flame, and that kills them; it burns their lungs and they never get over it. I have known men to drink a quart of fish-oil after inhaling the fire, but it didn't do any good. Miners can always tell when there has been an explosion, though they may not have heard or seen it; there is a peculiar sensation, a certain feeling in the air as if it was being drawn away from you, and then they know what has happened. Now, the books tell you that after an explosion 'black-damp' gathers along the floor of the mine, and suffocates the men who have been knocked down but not killed by the explosion. I never found it so. I have helped to get out lots of men hurt by explosions, and we always found we got along best close to the bottom. Another queer thing about an explosion of gas is, that just where you would expect it to have the most effect it has none at all. I have known men to be driving gangway, for instance, and get so far beyond the air-current that fire-damp would gather in the 'face.' (The "face" of a miner's working is the wall of coal or rock at which he is digging.) By and by some careless fellow would fire the gas, and men fifty or sixty feet back along the gangway would be burned to death, while those close to the face would not be hurt. The force of the explosion always travels against the air-current, and that little bit of motionless air at the face was left untouched, while the blast went out into the back workings. It does not even give the men in the face that shock that is felt by those who may be near, but not in its path farther out. I remember once I was driving a 'heading' from one chamber to another, when the gas fired behind me. I was not hurt or stunned, but the fire went out into the chamber my heading opened into. I ran right out after the fire and jumped down the breast into the gangway, where I found fresh air. A man can live a little while in after-damp, but he must not stay in it long."

It is frequently the case also that the first explosion is followed by others of less magnitude, but still dangerous. The first blast ignites "blowers" or streams of gas issuing from crevices, and these, as soon as a fresh explosive mixture of gas and air is formed, ignite and explode it. In one case which came under the writer's notice a mass of burning coal fired the gas, which exploded every fifty-five minutes with the greatest regularity and with great violence, shattering woodwork, dislodging large masses of coal and rock, and greatly damaging the mine. It took fifty-five minutes for enough gas to accumulate and for enough air to flow into the mine to form an explosive mixture. It is of rare occurrence that an explosion is so violent as to involve the whole of a mine in its action. It is usually circumscribed within a restricted area, and men may sometimes, if quick-witted, take such precautions as will carry them safely through

the midst of it. In the Wadesville explosion, elsewhere mentioned, a laborer, named Edward Weaklam, was engaged in loading a car, standing for that purpose on a low platform beside the gangway. To use his own words, he "saw the fire coming down the breast," and, quickly dropping off the platform, threw himself prone on the track of the gangway, grasping the iron rails with both hands. The explosion passed over him, leaving him unharmed, and, after it had spent its force, he groped his way to a purer atmosphere. Another, less fortunate, was held down by a mass of coal until suffocated by the carbonic acid gas. A man can easily hold his breath during the short time required for the passage of an explosion, and even if he cannot drop below the region of the fire-damp, it is well to hold the breath, and thereby avoid inhaling the flame, which may cause death while the external injuries are of a superficial character. (See Herbert's remarks above.) The medical treatment of sufferers by an explosion is the same as in other cases of burning; but it frequently happens that the victim, besides being burned, is injured by the shock, or by the force of solid bodies broken from the roof or hurled against him from some other direction. The force of the explosion is not less to be dreaded than its heat. When violent, everything breakable within its area is shattered; cars are propelled rapidly along the track for hundreds of yards, and if not thrown off by the impulse or by contact with some obstruction, are hurled back with equal force by the after-shock, to be dashed to pieces at last against the wall of the mine; and cases are frequent in which unfortunate men, caught by the full sweep of the blast, are hurled against the wall with a force that instantly kills them. In mines where this gas is found it is constantly escaping through cracks and fissures in the coal and its surrounding strata, often in such quantities as to make a hissing or rushing noise, while sometimes it appears to force its way through the solid coal itself with such violence as to force scales to fly off with a crackling noise from the general mass. "At the Prospect Shaft, near Wilkesbarre—probably the most fiery mine in the (Pennsylvania anthracite) coal-field—the make of gas has been so rapid that with a current of air from 20,000 to 30,000 cubic feet per minute passing through the gangway—twelve feet wide by seven high—it was impossible to proceed more than ten feet beyond the cross-heading connecting the gangway and parallel air-way, without putting in bratticing to carry the air up to the face; or with such bratticing—dividing the gangway into two parts, each six feet by seven feet, the velocity of air-currents being from 500 to 600 feet per minute—the gas would ignite at the face when the distance from the face of the gangway to the bratticing was more than fifteen feet. With such a prodigious discharge of carburetted hydrogen almost every blast would ignite it, and if the promptest measures were not taken the coal was quickly aflame." (R. P. Rothwell, M.E., Trans. Am. Inst. Mining Engineers, Vol. IV., p. 59.) The fact that a mine can be safely worked and blasting-powder freely used under such circumstances, is strong proof that fire-damp explosions nowadays are always due to somebody's ignorance or recklessness. In

the present state of mining science, however, the danger of fire-damp explosions is much less in new workings than in old ones. In recent excavations, the top and sides of the mine are comparatively fair and smooth, the workings of nearly a uniform height, the passages unobstructed, and there are few cavities in which the gas as it escapes can find lodgement and accumulate ; while in older mines, especially if the coal is thick, the chambers are apt to be of irregular height, masses of rock and slate fall from the roof, leaving holes in which the ventilating current cannot circulate, and here the carburetted hydrogen, which from its light specific gravity rises to the highest attainable point, finds ready lodgement. While it remains there, if sufficiently high to be out of the reach of the miner's lamp, it is harmless ; but continued accumulation soon forces it down, and in time causes it to fill the whole mine ; or, more dangerous still, a sudden fall of material from the top may carry down the gas with it, to ignite on the lamps of the men below. It was such a combination as this that caused the explosion at the Wadesville shaft, near Pottsville, May 9, 1877, in which five men were killed by the explosion of fire-damp, and one suffocated by after-damp. A searching investigation showed that the part of the mine in which the explosion took place was old and worked out. A few men were engaged in "robbing back"—taking out all the remaining pillars and supports—and in the course of their work (and contrary to express orders) had removed a door which served to divert the ventilating current into their workings. This permitted the air to stagnate and fire-damp to gather in some large holes in the roof of the mine a little way from them. Where the men were working the air was pure enough to permit their using naked lights ; but on the next morning after the door was removed a fall of rock occurred, the accumulated gas was forced down and through the workings until it reached their lamps, and an instant explosion followed.

It is a fact long known, but not sufficiently taken into account in mining operations, that the probability of an explosion of fire-damp is as readily foretold by the barometer as a gale of wind or a storm of rain. An English report quoted by Taylor (p. 110), says: "The combined indications of the barometer, thermometer, and wind, tell the state of a mine with the greatest nicety. When the barometer indicates a fall, the thermometer a rise, and the wind blows from the E.S.E. or south (in England), an ordinary fiery colliery will be certain to pass rapidly into a state of great danger." And Taylor adds: "The fall of the barometer is a sure presage of increasing discharge of inflammable gas; for when the barometer stands steadily—say at 29°—and the pressure is uniform, nothing exudes but the ordinary 'makings' of the mine; but when a sudden fall of the barometer portends a lightening of the atmosphere, and consequently a pressure upon the orifices whence the gas escapes, or upon the main body accumulated in the waste, then it is that extraordinary eruptions take place, enough to overpower and adulterate even the main current of air, and consequently to subject the mine to explosion."

Since the establishment of the Weather Bureau of the United States

Signal Service, several propositions have been made looking to the establishment of "danger signals" at the mines, by which warning of an approaching area of low pressure might be given in time to let the miners escape, or adopt proper precautions for safety; but as yet nothing has been done. Many schemes for the safe lighting of fiery mines have also been proposed, but nothing yet invented has been found equal to the safety-lamp, unsatisfactory as it is. Of this lamp there are several varieties, differing in detail, but alike in general plan, and all defective in illuminating power. A proposition which looked quite feasible on its face was made thirty or forty years ago, and has been revived at intervals since. It was simply to form reservoirs within the mine in which to store the exuding gas, and by means of suitable pipes to let it be conducted to all parts of the mine for illuminating purposes, thus lighting the mine and getting rid of the gas at one operation. The great objection to this plan, however, is that it calls for a greater supply of fresh air, to feed the flame, than is available in most mines, and produces an enormous amount of carbonic acid and nitrogen gases, thus adding greatly to the difficulties of ventilation. Another objection is, that the flow of gas is irregular, as just noted, and might at any time exceed the capacity of the reservoirs to hold it, or of the burners to consume it, in which case a terrible explosion might occur without warning. The latest proposition is the use of the electric light; and if this can be so controlled as to illuminate every working place at a moderate expense, and so arranged—by confinement in hermetically sealed globes or otherwise—as not to fire the gas, it is possible it may soon form an important adjunct to mining operations. Certainly in no other direction is there any indication of a light for miners' use that shall be at once brilliant, safe, free from deleterious effects, and not too costly for practical use.

The immediate effect of an explosion of fire-damp is to consume or expel the oxygen in the section subject to its influence, and as its force is often so great as to break down partitions, and sometimes the solid coal itself, the air-currents are checked, deadened, or reversed. (At a mine in Saarbrück, Prussia, an explosion broke timbers eight inches in diameter 900 feet from the scene. In a mine at Schaumburg, stones weighing more than a ton, the foundation of a machine weighing twelve tons, were displaced by an explosion.) Ventilation being thus destroyed, respiration is impossible; after-damp fills the mine, and carries suffocation to all who come within its influence. "This after-damp is formed of

Eight parts of nitrogen, having a specific gravity of 0.9722,
Two parts of aqueous vapor,
One part of carbonic acid gas, specific gravity 1.5277."

(This analysis differs slightly from that given on page 237). "The latter takes its place toward the bottom of the passages, and probably extends little more than six inches high. Hence it is inferred that when the men, after an explosion, if not struck down at once by it, attempt to leave the

mine, through an atmosphere of after-damp, they are at first rendered partially insensible by the nitrogen, which has been substituted for atmospheric air, and then falling they come in contact with a still more deleterious gas, a positive poison—the carbonic acid gas—which, having inhaled to a small extent, they pass rapidly into a state of asphyxia, owing to the state to which their systems have been previously reduced" (Taylor). An instance of the rapidly fatal action of carbonic acid gas, also given by Taylor, has been quoted frequently, but may be mentioned here. At Creuzot, France, the workmen one morning entered a shaft, following each other down the ladder placed for their use. At the bottom a stratum of carbonic acid gas had accumulated during the night to the depth of several yards. The first man to reach the bottom dropped, asphyxiated, from the ladder, without having time to utter a cry. The second stooped to raise him, and shared his fate. Those who followed, not understanding the danger, were prostrated, one after the other, as they strove to rescue their comrades, until the fifth man, an experienced miner, took the alarm, and obliged those behind him to reascend.

The presence of carbonic acid gas is denoted by a dull flame on the miner's lamp, which is extinguished when the gas becomes abundant, for neither light nor life can exist in it. The flame, however, is extinguished before life is, so that the miner has time to withdraw after his lamp is put out, unless, as in the case of the Creuzot miners, the gas is present in overwhelming abundance. An important exception to this rule occurs when the carbonic acid is mixed with nitrogen. In that case life is extinguished while a light continues to burn. The symptoms of asphyxia are, a cessation of respiration, of the pulsation of the heart, and of the action of all sensitive functions ; the countenance is swollen and marked with reddish spots; the eyes protrude, the features are discomposed, and the countenance often livid. In order to succor the victim, it is necessary to act promptly, vigorously, and perseveringly. The following general remedies are recommended by the South Shields committee, appointed in England in 1839, to investigate an explosion at the Hilda pit, by which fifty-two lives were lost: "Remove the patient immediately into purer air; undress and dash the body with cold water; if possible, make the patient swallow water slightly acidulated; administer clysters of two-thirds water and one-third vinegar, to be followed by others of a strong solution of common salt or of senna and epsom salts; inflate the lungs by artificial means. Should these means not produce the desired effect, and the body still retain its natural warmth, recourse must be had to bloodletting, which will be clearly indicated by the red face, swollen lips, and eyes protruding. If blood fails to flow from the jugular vein, an attempt should be made in the foot; the last effort which can be made is to make an opening in the trachea and introduce air to the lungs by means of a small pipe and a pair of bellows. The absence of the beating of the pulse and the want of respiration are not certain signs of death, nor should all be regarded as dead whose breath or pulmonary transpiration does not bedim the brightness of glass, nor those whose members appear stiff and in-

sensible." The miners' practice is much more simple: the sufferer is carried out and laid in fresh air; if he recovers, well; if not, "the gas was too much for him."

Too much care cannot be exercised to guard against carbonic acid gas in mines. It not only exists in large quantities in a natural state, but is constantly being formed by the exhalations from the lungs of men and animals, the products of combustion in the miners' lamps, the ventilating furnaces, and especially the small locomotive engines now so commonly employed. When mixed with common air it is only safe up to the proportion of five per cent., though it is said that some miners become so accustomed to it that they can breathe an atmosphere charged with twenty per cent. of carbonic acid. Inspector Roy, in his report before quoted, calls special attention to the insidious workings of this unseen but deadly foe of the miner. "The air," he says, in speaking of the comparatively shallow mines of Ohio, where natural ventilation is depended on to a very great degree, "is best in the morning, because the circulation is partially, if not wholly, renewed in the night, during the absence of the miners; but in the afternoon and toward quitting time it becomes very foul, and miners frequently leave work because their lights will no longer burn, or because they are so oppressed with languor and headache that they can no longer stay in the mine. The black-damp, however, is more insidious than direct in its operations, gradually undermining the constitution and killing the men by inches. By reason of constant habit, young and robust miners are able to stay several hours in a mine after a light goes out for want of fresh air, where a stranger, unused to such scenes, would fall insensible, and, if not speedily removed, would die."

Similarly, Mr. J. K. Blackwell, appointed British Commissioner of Mines in 1849, with instructions to make an inspection of their sanitary condition, reports: "There is another class of injuries, resulting from defective ventilation, to which miners are exposed. The circumstances producing these injuries are slow in operation, and as their effects bring disease, and not immediate and sudden death, their existence has been little considered. These effects are the result of an inadequate supply of air, which has become vitiated and unfit for breathing, on account of its having lost its due proportion of oxygen, which is replaced by the formation of carbonic acid. This gas has its sources in respiration, the lights of the mine, the decomposition of small coal in the goaves (worked-out spaces), and of timber in the workings. Air in this state is also usually found to be loaded with carburetted hydrogen, yielded from the whole coal or in the goaves. Sulphuretted hydrogen, arising from the decomposition of pyrites, is sometimes present, especially in coal-seams liable to spontaneous ignition. The gases formed by blasting are also allowed to load the air of mines to a very injurious degree."

And Thomas E. Foster, Government Inspector in 1864, says: "In collieries that I alluded to as being badly ventilated, they had no inflammable gas, *and that was the reason why they were not well ventilated.* Although you sometimes kill a few men by an explosion, those collieries where they

have no inflammable gas kill the men by inches. There are quite as many, in my opinion, killed where there is nothing but carbonic acid gas, as where there is inflammable gas. The men's health is naturally destroyed, and they kill them by inches. They do not go immediately, but they go in for a few years and die." Attention is especially called to Mr. Foster's remarks. Colliery managers are altogether too prone to think that fire-damp is the only "damp" that is to be feared, and force their men to work year after year in an atmosphere loaded with carbonic acid, because in this gas they die slowly and one by one, dropping off without any of the dramatic circumstances attending death by an explosion. It is cause for congratulation that the improved state of science and the requirements of the mining laws in all civilized countries have greatly improved the condition of the mines with regard to ventilation.

Nitrogen gas (azote, white-damp) is less to be feared than carbonic acid, because it occurs much less frequently. Its lightness, however, causes it to seek the highest parts of the workings, and thus it may affect the miner's respiration, while he walks harmless through a deposit of carbonic acid gas at his feet. Nitrogen makes respiration difficult, causes a hissing or singing in the ears and a heaviness of the head, and, when present in the proportion of 85 per cent. of the atmosphere (common air being composed of 21 per cent. oxygen and 79 per cent. nitrogen), produces asphyxia. The same proportion of nitrogen will extinguish a lamp. It is chiefly found in mines where there are iron pyrites in course of decomposition, or where a portion of the mine is on fire, being set free by the absorption or combustion of the oxygen.

Two or three fatal accidents from white-damp, which have recently occurred in the Pennsylvania anthracite mines, have called attention to this source of danger, which has always been too much ignored by the miners. At an inquest held on the body of Thomas Williams, a miner, who died from injuries received at Kalmia Colliery, it was found that the deceased had fired a blast at the top of a steeply pitching "breast," and, without waiting for the powder-smoke to clear away, had returned to see the effect, had been asphyxiated by the gases, and had fallen a long distance down the "man-way," receiving injuries which caused his death. A medical expert, who was a witness at the inquest, related a similar circumstance which came under his observation a few years before. Two men, working in the same "breast," fired a blast on each side simultaneously. One, who was in a hurry to go home, ventured back into the smoke, and almost instantly fell insensible down the "man-way." His comrade, who was in the "man-way" on the other side, seeing him fall, hastened to his assistance, but, before he could cross the breast, he too fell senseless. Neither was killed, and the man who happened to fall into the "intake" passage, by which fresh air was carried up to the working, soon recovered; but the other was resuscitated with difficulty. In both cases the mine was well ventilated, and the misfortune of the sufferers was attributable solely to their own reckless impatience. The explosion of the blast generated nitrogen—from the nitrate of soda or of potash used in

making the powder, and sulphurous acid from the sulphur, another ingredient—while the combustion consumed a portion of the oxygen in the vicinity and supplied its place with carbonic oxide and carbonic acid gases, the mixture forming the "white-damp" of the miner. As will be seen from the instances given, this gas, when present in large proportions, acts with great quickness, and though not so immediately fatal as pure carbonic acid, is apt to lead to fatal results, either primarily or from secondary causes, as in falling from a height while insensible. Its symptoms, as described by miners who have experienced it, are a sudden pain darting through the ears from side to side of the head, a sense of fulness or bursting in the head, and then giddiness. Though comparatively rare, it is to be guarded against where the air is heavily charged with powder-smoke, as well as where, under the conditions just described, nitrogen is to be apprehended.

Another evil too commonly met with in coal-mines is the cloud of dust with which the air is loaded. Where the coal is kept damp by the percolation of water, little dust is made, and the miner is comparatively free from its injurious effect; but it is exceptional for the coal to be in this condition, and it has been found that the deeper the workings penetrate the less water is found and the drier and more dusty the coal becomes. Any one who has seen a load of coal shot from a cart, or has watched the thick clouds of dust which sometimes envelop the huge coal-breakers of the anthracite region so completely as almost to hide them from sight, can form an idea of the injurious effect upon the health of constant working in such an atmosphere. The wonder is not that men die of clogged-up lungs, but that they manage to exist so long in an atmosphere which seems to contain at least fifty per cent. of solid matter. Ventilation mitigates this evil, but does not obviate it, as a stream of pure water flowing into a muddy pool, of which the bottom is continually being stirred up, will thin the contents of the pool, but will not make them clear. Every fresh stroke of the pick or the hammer, every shovelful of coal moved, every fall of a dislodged mass, causes a fresh cloud of dust, until the ventilating current would need to flow with a force little short of a hurricane to keep the miner's lungs supplied with unvitiated air. Inspector Roy, who has given much attention to the subject of mine ventilation, says (Report for 1876, p. 92): "Constant labor in a badly aired mine breaks down the constitution and clouds the intellect. The lungs become clogged up from inhaling coal-dust and from breathing noxious air; the body and limbs become stiff and sore, and the mind loses the power of vigorous thought. After six years' labor in a badly ventilated mine—that is, a mine where a man with a good constitution may from habit be able to work every day for several years—the lungs begin to change to a bluish color. After twelve years they are black, and after twenty years they are densely black, not a vestige of natural color remaining, and are little better than carbon itself. The miner dies at thirty-five years, of coal miners' consumption." Mr. Roy attributes the frequent strikes and other expressions of discontent among the miners primarily to

defective ventilation, saying: "The sources of discontent among miners arise, not, in my judgment, so much in the evil nature of the men, as in the evil genius of the miners; and not conspiracy laws are needed to compel miners to be law-abiding citizens, but better ventilation to expel the demons of the mines—those noxious gases which in remoter ages the priests of Germany were wont to combat with religious exorcisms." The following cases reported by Dr. William Thomson, show the condition of the lungs above referred to:

"D. C., aged 58; miner for 12 years; lungs uniformly black and of a carbonaceous color.

"D. D., aged 62; miner from boyhood; lungs uniformly black.

"G. H., aged 45; lungs uniformly deep black through their whole substance, with a density equal to caoutchouc.

"L. A., aged 54 years; miner all his life; whole lungs dyed with black carbonaceous matter."

Dr. D. C. Rathburn, of Middleport, Ohio, testified before the Ohio Mining Commission, on this subject, as follows: "I have made two post-mortem examinations in which there was carbonaceous solidification in the air-cells. The Scotch people call it spurious melanosis, really a coal-miners' consumption. I have no doubt the carbonaceous particles caused their death. I examined them after death because before their decease they spit up a black substance whose real character I wished to ascertain. Four cases came to my knowledge."

The black substance referred to is solid carbonaceous matter, inhaled while at work. As noted above, it is very slow to operate as a direct cause of death; but aggravates diseases of the lungs, acting principally as an irritant. Once in the lungs it remains there ever after, manifesting itself in a peculiar black sputum in all cases of expectoration from lung troubles.

Dr. J. T. Carpenter, of Pottsville, in his treatise before quoted, says: "I saw, a short time since, a patient suffering from chronic bronchitis, with coal-dirt sputa, who had not entered a mine for nineteen years. A gentleman of Pottsville, under my care, is now recovering from pneumonia, with softening and abscess of the lung, who in former years was engaged in mines, but has not habitually entered them for eight years past. During his recent illness the characteristic black sputum was constant."

Some mysterious explosions which have recently occurred in flour-mills and other places where the air is thickly mixed with particles of fine dust, and which were finally attributed to the rapid combustion of the dust itself and consequent expansion of its contained gases, have suggested a similar explanation of some otherwise unaccountable explosions in coal-mines. Thus, a late number of the *Chemical News* quotes M. D. Simonian as calling attention to "certain facts which prove that it is in the majority of cases the heating of the coal-dust diffused in the galleries of the mines to which explosions are due." Referring to the catastrophe in the Jabin Mine at St. Étienne (February, 1877), he states, on the authority

of the manager, "that the mine in question contains very little fire-damp and that the precautions hitherto taken with an exclusive reference to that gas are not sufficient. Others must be taken against the extremely fine coal-dust, which, at the moment of the explosion of slight amounts of fire-damp, or even of blasting-powder, liberates rapidly a part of the coal-gas which it contains, and propagates the explosion, reproducing the cause of the evil with so much the greater energy as the current of air is more violent. Thick crusts of coke (two or three centimetres) prove this fact and explain how it is that extensive tracts in which fire-damp has never been observed are burnt like the rest of the workings. Hence, it appears that the precautions to be taken in fiery mines are complex whenever the coal-dust is rich in gas and very finely divided. Explosions may then ensue even in mines where fire-damp is unknown. There is no need to suggest the cavities full of carbonic oxide, or of gaseous hydrocarbons, and suddenly laid open by a blow from the miner's pick." This is as yet too new to have stood any extensive test of practical application, but is worthy of attention, and if well founded is another argument for thorough ventilation.

Among the incidental evils of a miner's life is the frequent occurrence of fires in the workings. These are due to a variety of causes. Sometimes an explosion or a careless blast ignites the "blowers" of gas, and sometimes these are fired by the miners themselves as a source of light. In any case, if neglected, the coal ignites. Sometimes a carelessly hung lamp sets fire to the woodwork of the mines, and sometimes the coal takes fire from the ventilating furnace. The result is that the mine soon fills with wood-smoke and sulphur-fumes, immense quantities of nitrogen, sulphurous acid and carbonic acid gases are generated, and the air soon becomes unfit to breathe. It is necessary, however, that men should enter the mine and work against the fire, throwing water on it to extinguish it, or building walls or digging passages to stay its progress. It frequently happens that the air in which they work is so impure that the strongest men can remain in it only fifteen or twenty minutes. At the end of that time they frequently fall insensible from asphyxia, when they are carried out to daylight or to a part of the mine where the air is purer, and laid down to recover. No attention is paid them, and after a time they usually regain their senses, and often go back to take their places among the workmen. When the work is done or the attempt abandoned, they go home, bathe, and sleep for many hours, after which they profess to be thoroughly recuperated and to feel no ill effects from their semi-suffocation.

After what has been said, it is evident that the greatest necessity for healthful mining is good ventilation. With air-currents sufficient to carry off noxious gases, powder-smoke, and at least the most of the dust, mining becomes not merely a healthful, but an agreeable occupation, notwithstanding all that has here been said about its perils and drawbacks. The latter may seem a bold statement to those whose experience in mines is limited to a single visit, but it is the testimony of the great majority of

miners, and is confirmed by the well-known fact that men who go from farms and shops to work for a season in the mines rarely go back to their old work. There is something about the comparatively free and easy life of the miner, who is to a great extent "his own boss"—the uniform temperature, which in most mines varies little, if any, with the seasons, and which ranges from 45° to 65° Fahr., according to local circumstances, the year round—and perhaps the spice of danger which is always present, that makes the miner, once initiated, cling to that work for the rest of his life. Nor is that life necessarily a short one, though the appalling frequency of easily avoidable accidents reduces its average length far below what it should be. So far as the writer is aware, no comparative statistics of the average length of miners' lives, or of their liability to disease, have ever been published ; but old men are common among them, and men who have worked thirty, forty, or fifty years in the mines, and are still hale and hearty for their age, are by no means rare. Their principal diseases, as before stated, are miners' asthma, consumption, and rheumatism, and, among those who have worked long in badly ventilated places, dyspepsia, tremors, vertigo, and other troubles arising from blood-poisoning. (Carpenter, *ubi sup.*) The two principal causes are dampness and bad air. Pumps and precaution obviate the one, and proper ventilation the other.

Up to within a comparatively recent period the ventilation of mines was effected either by the natural force of the air-currents, or by heating the air in the upcast shaft by means of a furnace at its foot, thus causing it to rise and create a vacuum, which was filled by the air flowing in through the downcast shaft. The former plan, however, works well only when the opening of the upcast shaft is much higher than that of the downcast, and is not applicable to mines of any great depth ; while the furnace, besides being inadequate to the task of moving the air in a large mine, is liable to explode the gas and ignite the coal. Its use, therefore, is fast being discontinued, and the device known as the exhaust-fan, of various patterns, is taking its place. This is a wheel something like the paddle-wheel of a steamboat, enclosed in a wooden casing, and so arranged as to create a suction of the air as it revolves. It is set over the mouth of the upcast shaft, and driven at high speed by a small steam-engine. Exhaust-fans vary from ten to sixty feet in diameter, and from three to ten feet in face. Their powers vary greatly, not only with their dimensions, but with the size and shape of the mine-passages which the air has to traverse. Instances in which from 100,000 to 150,000 cubic feet of air per minute are moved by them are not uncommon, but about half these figures is a more usual accomplishment. With the exhaust-fan properly supplemented by a judicious arrangement of the mine-passages, there is no longer any reason why men should suffer from defective ventilation ; and it is a noteworthy fact that more attention is being paid to this important subject year by year, with a corresponding improvement in the general health and comfort of the miners.

In most occupations and conditions of life the subject of accidental injuries and death would form no part of an inquiry into the hygienic features; but mining is an occupation so peculiarly exposed to danger that a brief consideration of the principal classes of accidents, and the means by which they may be avoided, may not be out of place. The following figures, compiled from the official reports of the Pennsylvania Anthracite Mine Inspectors, show the ratio of killed and injured to the total number employed in these mines. In the seven years, 1871 to 1877 inclusive, the figures were as follows:

Average total number of persons employed, 66,842.

Year.	Killed.	Injured.
1871	271	664
1872	223	611
1873	266	688
1874	262	558
1875	238	587
1876	228	473
1877	194	590
	1,682	4,171
Yearly average	240	596
Percentage	0.36	0.89

Thus on an average one and a quarter per cent. of the men employed in and about coal-mines are killed or wounded by accidents every year.

Mine Inspector Jones, of the South District of Luzerne and Carbon Counties, Pennsylvania, gives a tabular statement of the causes of accidents in his district for the seven years above named, which is interesting as showing the comparative frequency of the different classes. The totals are as follows: Explosions of carburetted hydrogen gas, 10; falls of coal, 78; falls of slate and rock, 26; falling into slopes, 4; hoisting-machinery breaking, 6; sundries in slopes, 5; by mine-cars, 29; by explosions of blasting-powder, 4; by mules, 1; by premature blasts, 8; by sundries, 14. Above ground: By machinery, 6; by suffocation in breaker-shutes, 2; by mine-cars, 7; by sundries, 7. Totals, above ground, 22; underground, 185.

Mr. Jones's district is the smallest of the six into which the Pennsylvania anthracite region is divided, having but 13.8 per cent. of the working force of the region, and his list of casualties is to be taken in the same proportion. It will be seen that while the list of dangers to which the miner is exposed is a long one, there is one class which gathers in more than all the rest combined. Of all the casualties enumerated, 57.24 per cent. are caused by falls of rock, coal, or slate, while less than five per cent. are due to exploding gas.

It would occupy too much space to enter into a discussion of the various ways in which men are caught by the falling fragments from the

roof and sides of the mine. The variety is almost endless, and in many cases the accident is so clearly attributable to carelessness, that it almost looks like a case of suicide on the part of the victim, or of manslaughter on the part of some other person. It is sufficient here to quote the vigorous opinion of Inspector Williams, of the Middle District of Luzerne and Carbon, an intelligent and experienced miner, in his official report for 1877. He says: "I have become satisfied in my own mind, long ago, that fifty per cent. of the accidents from falls of roof and sides could and should be avoided, and that fifty per cent. more timber used in our mines, when properly placed, would be the means of saving (preventing) twenty-five per cent. of the accidents just referred to." The other twenty-five per cent., though they may not be preventable by proper timbering, may be easily avoided by the use of a little precaution and knowledge of mining.

In conclusion, it is the opinion of the writer, formed from long personal acquaintance with the subject, and sustained by the almost unanimous testimony of practising physicians, mining engineers, colliery owners, and miners themselves, that, were it not for accidental injuries and deaths, the mining class would show as good average health, as fair a percentage of longevity, and as low a death-rate as any other class of manual laborers; that the hygienic conditions of American mines are receiving more attention and consequent improvement year by year, and that, if the average miner could only be taught to exercise caution and common sense about his work, the list of fatal accidents would be materially shortened, and mining would lose most or all of the terrors which now invest it in the minds of the general public.

THE HYGIENE OF METAL MINES.

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THE HYGIENE OF METAL MINES.

THE lucid and interesting chapter contributed to the present volume by Mr. Sheafer deals especially with the hygienic conditions of coal-mines, including the laws of those explosive or noxious gases which are peculiar to such mines. It is true, as a general proposition, that, apart from these coal-mine gases, the conditions obtaining in collieries are similar to those of mining for metallic ores; but there are some differences which should be recognized, and which may justify me in supplementing Mr. Sheafer's account with a few remarks more particularly applicable to metal mines. I shall make no attempt to avoid repeating portions of a paper on the subject which I have been engaged in preparing for presentation to the American Institute of Mining Engineers.

The chief differences in this country between the sanitary conditions of coal-mines and those of metal mines are the following:

1. The coal-mines are, as a rule, neither very deep nor very high above the sea level; whereas a large proportion of the metal mines are situated at great altitudes (5,000 to 13,000 feet above tide). The comparative rarity of the atmosphere, though not perhaps injurious to health *per se*, nevertheless intensifies the changes of temperature to which both the mountain climate and the underground work render the miner liable, and thus promotes certain febrile and rheumatic complaints.

2. Although it cannot be said of American metal mines, in general, that they are deeper than the coal-mines, yet it must be admitted that they grow deep faster, and that the deepest of them far exceed our coal-mines in this respect. In some cases—notably in that of the Comstock Lode—the increase of heat in depth is a very serious inconvenience and injury to the mining work.

3. With rare exceptions, metal mines do not generate poisonous or explosive gases in large quantity or in brief periods. Slow decomposition in the rocks of minerals such as pyrites may give rise to sulphurous or sulf-hydric gases ; carbonic acid may be generated by decaying wood, or by the burning candles, or the exhalations of the workmen ; but there is no such imminent danger from these sources as threatens the coal-miner, who may be overwhelmed by a sudden irruption and explosion of "fire damp," or drowned in a flood of "black damp." On the other hand, this

immunity from sudden catastrophes due to imperfect ventilation leads, in metal mines, to a degree of carelessness in this department of mine engineering of which no one would dare to be guilty at a colliery. As a rule, therefore, the air is much worse in metal mines than in coal-mines. The former are usually left to ventilate themselves, according to aërostatic laws; and when changes of wind or season cause a reversal or stagnation of the ordinary current, the phenomenon is submitted to with a kind of fatalism. Miners say "the air is bad" in this or that level, very much as one would speak in helpless resignation about the weather out of doors. When the heat or foulness of the air at any point actually prevents work, remedies are applied; but so long as it is merely an inconvenience or a slight enhancement of the price per yard of contract work, it is too often neglected, since neglect is not exposed to the death penalty.

4. The greater expense and completely unremunerative character of excavations in rock such as usually incloses metalliferous deposits, leads to the making of much smaller and less regular passages than the gangways of collieries; while separately excavated airways may be said not to exist in metal mines at all—a brattice or an air-box or a weather-door now and then being the most that is done for the artificial direction of the ventilating current. The smallness of the excavations in metal mines is therefore another cause of imperfect ventilation. On the other hand, the old workings, particularly if well-packed with "deads" or waste-rock, do not need to be ventilated so much as is often the case in coal-mines, to prevent the accumulation of dangerous gases in them.

5. There is, as a rule, much more climbing in metal mines. The miners often descend and ascend through great vertical distances by means of ladders and stairs.

6. It is in a few localities only, apart from the coal regions, that a permanent class of miners exists. Moreover, the hygienic conditions of most American metal mines are not extreme; and, finally, the effects often attributed to underground conditions, in other countries, may be largely due to other causes, and it may be that better diet, less prolonged and exhaustive labor, more comfortable homes, and more rational habits have to some extent rescued the American miner from the evils which have been supposed to inhere in his avocation.

The points thus suggested will now be briefly reviewed, under the heads of physical exertion, air, and temperature.

Physical exertion.—The wielding of sledge and pick, the pushing of cars, the wheeling of barrows, and the lifting of heavy rocks and timbers are forms of exertion which the miner undergoes in common with laborers of many other classes, and which cannot be deemed, apart from the peculiar conditions surrounding them, specially injurious to health, though they are doubtless more or less competent to cause or to aggravate certain organic diseases. The ascent and descent upon ladders may be considered characteristic of this avocation, though it is involved also in the ordinary method of raising bricks and mortar to buildings in process of construction. Here the hod-carrier not only climbs, but climbs frequently, and

carries a heavy load—a practice once common in the mines of Mexico and South America, but unknown in this country, from which its cost as well as its inhumanity has excluded it. It is the custom now to use windlasses or hoisting engines even for buildings, when these exceed one or two stories in height; and it must be remembered that the highest buildings come far short of the vertical extension of ordinary mines. The question, how much the health and efficiency of miners are affected by climbing up and down ladders, has been carefully examined. The loss of working-time involved in this method of transit is serious. But the exercise of climbing itself, if taken slowly and with due caution, and if the heated climber is not afterward exposed to a chill, is not generally held to be injurious to healthy and strong men. Added to other enfeebling conditions, it is said to hasten the period of declining strength; and it is an important objection to the use of ladders in deep mines that they necessitate the employment of the younger men in the lower levels, and thus deprive the mine, at the points where skilled labor is most desirable, of the services of the oldest and most experienced workmen. Ladders placed at a proper angle are better than stairs, since they permit the arms to take part in raising the body. The loss of time and the waste of strength involved in ladder-climbing are shown by the relative amount of work done per man in the upper and lower levels, this amount being, for instance, in the lead-mines of the north of England, one-fifth greater in the upper levels. On the question of health, it may here be added that sailors are not reported to suffer from climbing any more than bricklayers do; and the sum of the whole discussion appears to be, that the economical view of the subject of climbing in mines is more important than the sanitary one.

This view has led to the introduction of the man-engine, and the practice of lowering and raising workmen in skips and cages. This is not the place for a criticism of the comparative merits of these devices. It is sufficient to say that in most of those American mines which are deep enough to render the use of ladders a matter of hygienic importance, the workmen are lowered and raised by the machinery that hoists the ore; and the ladders being kept merely as a means of transit between neighboring levels, or as a resort in case of accident, do not enter into the hygienic problem.

Air.—The most thorough and satisfactory reports on the air of metal mines are those of Dr. R. Angus Smith and Dr. A. J. Bernays, included in Appendix B to the Report of the Commissioners, appointed to inquire into the condition of the metal mines of Great Britain, with reference to the health and safety of the persons employed in such mines. (London, 1864.) Dr. Smith begins with an elaborate discussion of the normal amount of oxygen and carbonic acid in pure air, and, after citing many analyses of distinguished chemists, adopts 20.9[1] parts by volume of oxygen, and 0.04 of carbonic acid as a fair out-door average, and shows that in confined spaces, and under various influences, the amount of carbonic

[1] The proportions given throughout this chapter are parts in 100, by volume.

acid may be increased indefinitely. At 11 P.M., in the pit of a London theatre, it was 0.32. But many samples of bad air, taken from mines, have shown over two per cent. of carbonic acid. By a series of most interesting experiments, conducted in a hermetically closed lead-chamber, containing 170 cubic feet of air, Dr. Smith established, among other important results, the following:

A person shut up in the chamber for five hours raised the amount of carbonic acid to 2.25 per cent. In this atmosphere the breathing was changed from 16 inspirations per minute to 22, and the pulse fell from 76 to 55, becoming, at the same time, so weak that it was difficult to find. On another occasion, when the carbonic acid had risen to 3.9 per cent., the number of inspirations advanced to 26, and the pulse became so weak as to cause alarm. This is a symptom of poisoning by carbonic acid. An experiment, tried by blowing carbonic acid into fresh air, containing 20.1 oxygen, without removing the oxygen, showed that the pulse of the subject was weakened, though breathing was not very difficult, and the candles burned moderately well. Four miners' candles, inclosed in the chamber, ceased to burn at the end of five hours, having raised the temperature from 50° Fahrenheit to 65°, and vitiated the air until it contained 18.8 oxygen and 2.28 carbonic acid. It follows that men can live where candles will not burn; but that the poisonous effect of carbonic acid begins before its subject is conscious of serious inconvenience. Moreover, it appears that the presence of carbonic acid is a more noxious agency than the mere diminution of oxygen in an otherwise pure air. According to Dr. Smith's experiments, respiration is not affected sensibly by a small or even a considerable diminution of oxygen, when the place of that gas is not taken up by others of a harmful character. But we do not usually have to deal, in mines, with simply rarefied or deoxygenated air. The abstraction of oxygen is due to processes which load the air with such gaseous products as carbonic acid. The facility with which water absorbs certain percentages of its weight of carbonic acid and other gases, explains the fact that the air is more tolerable in wet than in dry workings. Trickling streams or spray perceptibly improve the ventilation; and this means is occasionally resorted to for enabling men to continue work where it would otherwise be difficult.

Dr. Bernays points out another most important fact, namely, that there is a great difference in the personal sensations of comfort or distress occasioned by breathing different atmospheres containing practically the same proportion of carbonic acid. This is undoubtedly the effect of organic impurities, which greatly aggravates that of the carbonic acid. A much larger proportion of the latter may be breathed with impunity when it is the result of inorganic processes, and particularly of the slow oxidation of coal, than when it proceeds from animal exhalations, and the quick, smoky combustion of candles. Dr. Bernays says that he has often found the air of a crowded room intolerable, though it contained not more than 0.1 per cent. of carbonic acid. He mentions also, as a curious fact, that a man may continue to breathe without distress in

a confined space so long as it is contaminated by his own breath only, though he could not, without great disgust, enter an atmosphere rendered equally foul by the respiration of others. But I suspect that the inference he suggests is not well founded. It is, perhaps, not the source of the contamination, but the entrance of the observer from purer air, that makes it more repulsive in the latter case.

Carbonic acid and accumulations of organic impurities are most troublesome at the ends of galleries, or in confined stopes, winzes, etc., which are not swept by the general current of ventilation. The operation of blasting in such places has the good effect of breaking up the stagnation of the air: but, on the other hand, it contributes certain impurities of its own, partly volatile, and partly in fine, suspended floating particles. Carbonic acid, sulphuretted hydrogen, sulphide, and nitrite of potassium, etc., are among the products of explosion from ordinary gunpowder. Gun cotton is less harmful in this respect, and was recommended by the British Commission; but it has never found general application in mines, perhaps because its use in mines as a quick and violent explosive, has been superseded, or rather forestalled, by the various nitroglycerine compounds. It is well known that the gases from these produce most distressing headache; but this appears to be the effect on those persons only who are unaccustomed to them. I have seen miners return to a stope almost immediately after a blast of dynamite, apparently without inconvenience. This was, however, in a well-ventilated mine. With all explosives it is necessary and customary to allow the gases to clear away before resuming work.

Sulphuretted and arseniuretted hydrogen may be given off by rocks which contain such minerals as pyrites of iron or copper, mispickel, etc., which undergo decomposition in the presence of air and moisture. To this cause, in part, may be due the alleged unhealthiness of the copper-mines of Cornwall as compared with the tin-mines, in which the ore, being already an oxide, suffers, upon exposure, no chemical change.

Besides the gaseous impurities of the air, the dust produced by drilling has been considered a source of disease. This is probably not a serious evil. The almost invariable practice is to put water in the bore-holes to facilitate the work, and there is from this source little or no dust to be inhaled. What has sometimes been mistaken for mineral dust in post-mortem examinations of the lungs of miners, is finely divided carbon; and this is almost certainly attributable, not so much to the occasional inhalation of gunpowder vapors as to the constant breathing of the products of the imperfect combustion of candles. Some reported cases of the "lead-colic" among lead-miners may have been due to the inhalation of plumbiferous dust, or to the drinking of poisoned water.

The effect of all these impurities of the air has been found on the continent of Europe and in Great Britain to be a peculiar form of "asthma," "consumption," or "anæmia," known as the miners' disease. It is difficult to say how much the general low tone of vitality due to insufficiency of animal food, lack of healthy dwellings, and reckless personal habits,

contributes to the prevalence of this disease; but it is probably fair to conclude that these causes weaken the ability of the workman to resist the effects of the impure air in which he works.

Temperature.—There is a gradual increase of temperature in the rocks of the earth's crust, below the zone of uniform temperature which is found near the surface. The law of this increase in temperature is not clearly established. It is certainly much affected by the chemical reactions which may go on in the rock. Mr. Robert Hunt, in his testimony before the British Commission, says that whatever may be the temperature of the atmosphere on the surface of the earth, there is in the Cornish mines a constant temperature throughout the year at the depth of about 150 feet. Below that point, he says, the increase is one degree Fahrenheit for every 50 feet down to about 750 feet; then one degree in every 75 feet down to about 1,350 feet; and below that, about one degree to 85 feet. Mr. Henwood (quoted by Prof. J. A. Church, in his paper[1] on the Heat of the Comstock Lode) gives for different kinds of rock the following distances in feet, corresponding with each rise of one degree: granite, 51; slate, 37.2; cross veins, 40.8; lodes, 40.2; tin lodes, 40.8; tin and copper lodes, 39.6 ; copper lodes, 38.4. These figures show how great is the variation due to local causes. Assuming the increase in granite to be least affected in this way, and applying also Mr. Hunt's formula for the rate of increase, we may adopt as a probable standard of comparison a scale of depths and rock temperatures, as follows:

Depth—Feet.	Temperature of rock.
150	60°
300	62°
600	66°
1,350	76°
2,000	84°

It will be generally admitted that most mines are hotter than this, the fact being that the heat given off by lights, explosives, animals and men is not immediately removed by the ventilation, and hence the rock is perceptibly cooler than the air. But chemical reactions and hot springs in the rock may very greatly raise its temperature; and when this is the case, the miners, finding that the rock feels hot, in comparison with the air, say that the lode or the wall "makes heat." Even when the air is still somewhat the warmer, the rock may seem to be so when touched with the hand.

One of the United mines in Wales is mentioned by Prof. Church, in the paper already cited, as possessing springs which discharge water at 116° Fahr., the depth being 1,320 feet. The heat of the air in the workings is given at 100° to 113° Fahr. The hottest mine in Cornwall is, or was in 1862, the Wheal Clifford, concerning which the superintendent,

[1] This paper was read May, 1878, at the Chattanooga meeting of the American Institute of Mining Engineers, and will be published in Vol. VII. of the Transactions of that society.

John Richards, testified that the temperature was 102° fifty-one feet below the 1,200 feet level, and "a pretty deal hotter" (120° he guessed) at the 1,380 feet level. At one time, in a confined working, the temperature was known to rise as high as 128°. Mr. Robert Hunt, speaking apparently of the same mine, says that, by his personal measurement, the air showed 110° in the deep level, and that tests of the rock, made by leaving a thermometer for two hours in a bore-hole, gave from 112° to 114°. He reports the maximum with which he was acquainted as 117°. Mr. Richards says the workmen can endure 120° perhaps half an hour, but cannot continue to work for an hour at 102°, while they can make a four-hour shift without interruption at 95°. Mr. Hunt gives the average time of working at twenty minutes, and says that, on retreating, the men washed themselves in water at 90°, to cool off. Six sets of men were employed, so that each set had one hour and forty minutes in which to recover from the effects of the twenty minutes' exertion. Four turns of twenty minutes, thus distributed through an eight-hour shift, constituted a day's work. It is not surprising that, under these circumstances, the labor account was heavy. It is said that three guineas per inch was paid for driving a cross-cut in this mine.

These remarkable statements are even surpassed by the recent experience of the deep mines on the Comstock Lode in Nevada. For many data on this subject, corroborating and completing my own hasty observations and recollections, I am indebted to the paper of Prof. John A. Church, of Columbus, Ohio, already mentioned, and to the unpublished memoranda of that gentleman, generously placed at my disposal. In the lower levels of these mines (say about 2,000 feet below the croppings of the Gould and Curry, the usual datum-line) the temperature of the rock is generally about 130°. In freshly opened ground the air usually varies from 108° to 116°; but higher temperatures are not unfrequently reported, as, for instance, 123° in the 1,900 feet level of the Gould and Curry. The water, which enters the drift from the lode and the country rock, is, however, often much hotter. The vast body which filled the Savage and the Hale and Norcross mines for many months had the temperature of 154°. But the water, like the rock and the air, varies in this respect in different portions of the mines. The ordinary range of "hot drifts" is 105° to 110° air-temperature. The ventilating current is delivered at a temperature of 90° to 95°, which seems to be most conducive to comfort. It is blown upon the men through zinc pipes by means of powerful mechanical blowers. The question of present interest being the effect upon the health of the miners of working under such conditions, further description of the peculiar phenomena of the case will be unnecessary.

Before considering the health of the Comstock miners, it should be noted that by no means all, or even the majority of them, are employed in the hot drifts, and, moreover, that these mines are provided with arrangements which enable every miner to bathe and change his clothing immediately upon emerging from underground.

The diseases of the Comstock miners are mainly typhoid and mountain fever, rheumatism, and erysipelas. There is little or no consumption, bladder, kidney, or liver disease. The superior ventilation (apart from the question of temperature) in the mines, the hearty and abundant diet of the miners, the constant enormous activity of their perspiratory functions, and the personal cleanliness resulting from their daily baths, seem to have abolished among them the disease, supposed elsewhere to be characteristic of their avocation. It is admitted by all observers that they are healthier than their wives and children.

As to the immediate effect of the high temperatures upon those who work in them, it must be confessed that, while actually working, the men display apparently undiminished vigor, delivering with seven, eight or even nine pound hammers very rapid and effective blows. Perhaps a third of the time is lost in resting and cooling. In very hot drifts, a relief gang is employed; and, in extreme cases, four and even six men to the pick have been found necessary. In the main, however, the rapid progress in the hot drifts is remarkable, and shows that the heat does not greatly lessen the power of work, except by necessitating longer or more frequent rest. At the usual temperature of 108°, three shifts of three men each, working in turns of eight hours, advance three to five feet daily in hard rock. This is so much better than the efficiency reported from the hot lode in Cornwall, that we are led to infer that the method of delivering air to the Comstock drifts affects the temperature and perspiration of the miners in such a manner as to protect them to a large extent from the otherwise distressing action of the heat. My own sensations, as I recall them, in a deep and very hot level of the Crown Point (about 116°, I believe), were not specially uncomfortable on the surface of the body, except when a drop of still hotter water fell upon me. The principal feeling of distress was internal, and was caused by the inhalation of the scorching air.

The question whether those who labor in such places are permanently injured, is more difficult to decide. One of the physicians at Virginia City has declared that "there is not a sound heart in any man on the lode who has worked in a hot drift for two years." This statement is perhaps too strong, though it is possibly true that many of the miners are organically affected. Yet this appears not to interfere with ordinary and equable work, though it may, perhaps, develop into distinct disease under special strain or excitement. After long work in the hot drifts, the men have a waxen color, and are known as "tallow-faces." Prof. Church noticed some men who, without being lazy, showed unusual care in handling their work, and two or three of them told him that they were "broken down" in hot drifts. In the only instance in which the time required for "breaking down" was given, the workman had been employed underground six years.

The actual effect of the heat on the men is, first, excessive perspiration, and, if this is not removed by evaporation with sufficient rapidity, great faintness. The pulse increases, as is shown in the following interesting data, obtained by Prof. J. D. Whitney and Prof. Church, in the 1,800 feet

level of the Julia Mine, the drift being about 1,200 feet long, and having an air-temperature of 108° to 110°, while the air-temperature at the station or junction of the drift with the (downcast)[1] shaft was only 84°. The following observations were made:

	Pulse-beats per minute.
Carman, after bringing out car, say 1,200 feet	140
" after resting at station	64
" (another case) after partial rest	128
Prof. Whitney, after walking through drift	120
" " normal rate	60
Prof. Church, after moving about, without exertion	88

A case of death is reported as follows: A powerful man, accustomed to hot drifts, returned to work after a rest of three months, and entering the Imperial Mine as carman, pushed his first car to the end of the drift, in the 2,000 feet level—say 1,000 to 1,200 feet—loaded it, and brought it back to the station, where another man was waiting to relieve him. But, instead of taking his turn, he dumped the car and started back without cooling off. He loaded the car again at the end of the drift, and proceeded to return, but was found a few minutes later hanging senseless to his car, and died, I believe, before he could be got to the surface. Another died in the Imperial incline while that was sinking. Three such deaths in all are reported from this mine, which is an excessively hot one. Sometimes accidental deaths may be the indirect result of the faintness caused by the effect of the heat on the circulation. Thus a man fell down the Imperial (upcast) shaft last year, who was probably overcome by the heat while putting in timbers. In these worst places, strong and healthy young men are employed. Fat men seem to stand the heat best, and, among visitors, women endure it better than men. Some men wilt under the work, and are said to have "no pluck." Drinking habits unfit the miner for this severe test. Unaccustomed men are often unable at first even to reach the end of the drift where they are to work. An intelligent miner told Prof. Church that the first month of such work after a long rest is hard; then come three months of brisk feeling; and then follows a "dragged-out" sensation.

The underground use of machine-drills, operated by compressed air, is an important aid to ventilation and cooling, since the expansion of the escaping air absorbs much heat from the immediate neighborhood. But when, as in the Comstock, the heat radiated from the whole surface of exposed rock is far in excess of that which men and lights supply, nothing can sensibly reduce it, or mitigate its effects, except abundant mechanical ventilation. This is carried to a large extent in the Comstock mines; and to the fact that, in counteracting the high temperature, the impurities of the air are thus removed the remarkable good health of the Comstock

[1] The downcast shaft is that which conveys the fresh air into the mine, while the shaft through which the vitiated current ascends is called the upcast.

miners may be partly ascribed. Other causes have been already mentioned, such as the healthy mountain climate, the good food, and the comfortable dwellings. Finally, the fact must not be omitted from consideration that the miners of our western regions are immigrants, and presumably men of such bodily vigor and health as their adventurous spirit would imply.

Incidental to the question of temperature is the effect of sudden changes of temperature, such as are experienced on coming suddenly from the depths of a mine to the surface. The hygienic conditions here do not differ from those which any similar change of temperature produces; and since they may easily be counteracted by the prudent miner, they need not be set down as sources of disease inherent in his occupation.

Another kindred question relates to the effect of barometric pressure, which varies in mines with the depth of the openings, and also with the changes of the outside weather. The general experience is that high barometric pressure, though it permits a greater inhalation of oxygen with each breath, causes a feeling of distress, and affects the heart unfavorably. Dr. Bernays says that undoubtedly the most injurious, as well as the most unpleasant, condition of mine air is that in which a high temperature is accompanied with excessive barometric pressure and great humidity. The effect of the pressure alone can best be studied in the records of work in highly compressed air, as in the sinking of the caissons for the East-River and other bridges. It may be affirmed, as a general rule, that sound men are not permanently injured by it. In ordinary mines the chief sensible effect of the barometric pressure is the variation it may cause in the natural ventilating current. Where the ventilation is wholly or partly artificial, these changes may be controlled. The introduction of compressed and cool air by machinery tends powerfully to reduce to a minimum the humidity of hot mines, and thus (as in the Comstock) to give an atmosphere in which free perspiration, rapidly evaporating, cools and refreshes the body. A comparison of the statements above made, as to the Comstock miners and the miners in the hottest mine of Cornwall, shows how much more can be endured and accomplished by workmen when thus protected from vitiated or over-humid air.

The injurious effect of working under artificial light, instead of sunlight, has been often asserted; but there is no definite proof of it. Where other conditions are wholesome, and the habits of the workmen are regular, this is not likely to have a traceable effect. At all events, it is subordinate to many other causes.

General conclusions.—The British Commission, to which reference has been made, summed up its voluminous report in a few conclusions and recommendations, the substance of which I quote below, in order to point out how far they are applicable to miners in the United States.

The Commission finds that a large proportion of the diseases affecting miners in the metal mines is to be ascribed to defective ventilation only. However various the opinions of physicians concerning the causes of the disease so well known under the name of miners' consumption or miners'

asthma, there is in one respect a remarkable unanimity among all the experts, namely, that the health of the miner is chiefly affected by the quality of the air in which he works. This conclusion is emphasized by the results of very wide inquiry on the part of the Commission.

In the coal-mines, where special attention is paid to ventilation, on account of explosive gases, the mortality of miners, apart from accidents, is lower than in the metal mines. Starting from this significant fact, the Commission recommends that some of the methods of artificial ventilation employed in the former should be more generally introduced into the latter, and favors particularly the use of furnaces in "upcast" shafts, to accelerate the natural current by heating the upward-moving column of vitiated air, and to prevent the stagnation or reversal of the current by change of season or weather.

With reference to other causes of disease, the Commission recommends that every mine be provided with a conveniently situated, separate house, in which the workmen may change and dry their clothes; that boys under fourteen be not permitted to work underground; and that mechanical means be adopted for transporting the miners into and out of the mines. The man-engine is praised; but the system of hoisting the men in skips and cages is also pronounced satisfactory, provided the machinery be properly constructed and carefully tended.

These recommendations are as timely now as they were ten years ago, except that the increasing use of compressed air in mining has furnished an aid to ventilation not then considered. There is no proof that the metal miners of America are less healthy than other laborers, and there is no need that they should ever become so. In my judgment a wise regard for financial economy alone will cause capitalists to do all that philanthropic considerations would require in dealing with the problem of hygiene in mines—a problem which contains, as the foregoing discussion shows, no fatally insuperable difficulties, and no insoluble mysteries.

Metallurgical works. — The sanitary management of metallurgical works is a topic too vast and complicated to be treated in this chapter. It comprises questions of poisoning by gases or metallic vapors and through the handling of poisonous substances. The effect of the blast-furnace tunnel-head gases (carbonic oxide and carbonic acid) upon men too long exposed to them, is well known to ironmasters. But this is a sudden and usually transitory matter. A few drops of sulphuric ether, drunk in water, and a few hours' rest, will restore a man who has been "knocked over" by the gas. The effects of lead, arsenic, or quicksilver vapors, on the other hand, are more insidious and more enduring. But science furnishes, and the best practice employs, preventions as well as antidotes to the injury which might result from such causes. The prime requisite in all metallurgical or chemical works is thorough ventilation, coupled with arrangements for confining and conducting away the noxious gases or vapors. Here, also, economy takes sides with philanthropy. Not only does the hygienic question influence the rate of wages and the efficiency of labor, but the fumes which are so harmful if they escape are val-

uable to catch and utilize. Condensers, flues, chemical precipitants, etc., are therefore very generally employed to arrest the liquid and gaseous waste products of metallurgical works. The tunnel-head gases of iron blast-furnaces are valuable as fuel for driving the blowing engines and heating the air of the blast, and are so thoroughly utilized for this purpose that, when they finally escape from the tall chimneys of such works, they contain little else than moisture, nitrogen, and carbonic acid—the last of which, however deleterious by itself, or in certain proportions, to breathing animals, is, in its due place, a most important ingredient of the normal atmosphere, and intimately connected with the processes of mineral decomposition and vegetable growth by which the earth has become, and can remain, habitable for man. Nor has it ever been found that the free atmosphere in the neighborhood of great metallurgical works, or of great cities, is rendered unwholesome by the immense quantities of carbonic acid poured into it by chimneys and lungs.

The mechanical protectors (Tyndall's respirators, and the like) and the preventive or remedial measures, adopted in various cases to counteract the effects of poisonous gases and vapors in metallurgical works, can only be alluded to. Some of them belong perhaps more properly to the departments of toxicology and general therapeutics.

In securing abundant ventilation for metallurgical works, strong draughts of air are inevitable; and one of the commonest dangers to workmen arises from this source. Not only the heat of the furnaces, or of the flowing molten metal, but also the intense periodical activity which characterizes many metallurgical processes, produces free perspiration, and renders the body sensitive to a chill. There is no remedy for this evil, so far as I know, but common sense on the part of the individual laborer.

With a few exceptions (yearly growing fewer), there are no metallurgical industries in the United States which have not been, or by recognized means might not be, made as safe in sanitary respects as purely mechanical industries are.

PART II.

PUBLIC HEALTH.

INFANT MORTALITY—VITAL STATISTICS.

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INFANT MORTALITY.

The importance of the subject of infant mortality is at once apparent when we reflect that of all the deaths that occur in the great cities of North America, from a quarter to a third take place under one year of age, and from two-fifths to one-half under five; and that out of one hundred live-born children about twenty-five die before the end of the first year of life, and from forty to fifty before reaching the close of the fifth year.

It can hardly be necessary that stress should here be laid upon the enormous waste of life that is implied in these facts, and upon the necessity of using every discoverable means for its diminution. In presence of disease and death, the hygienist has but one preoccupation, namely, prevention. We will therefore at once proceed to study the nature and causes of the diseases which occasion the undue mortality of early life, with a view to ascertaining in what way and in what degree the manifold agencies concerned in its production may be amenable to control by sanitation.

Methods of Estimation.

The prevalence of fatal disease among infants and children in any population is recognized and estimated by statistical data derived from registration. From the yearly records of vital statistics, which are collected and published by public authority in every civilized community with more or less fulness and accuracy, the frequency of death at various ages can be calculated, and the variations of mortality in different localities and at different periods of time can be estimated and compared. There are various ways of using such data for the purpose of ascertaining and expressing the mortality at any age of life.

The first and most accurate method consists in determining the *death rate*, by which is meant the number dying in one year among one thousand living. The mortality of infants and children is most commonly represented by the death rate in one thousand living under one year of age, and under five years of age. The data from which death rates are calculated are two-fold, comprising, in the first place, the number of the living, more or less accurately determined by a census, or estimated by approxi-

mative calculations; and, in the second place, the number of the dying, derived from yearly mortality records. The taking of a census, with a careful enumeration of the population at various ages, being an event of somewhat rare occurrence, death rates cannot always be determined in a thoroughly satisfactory manner.

Another way of estimating infant mortality consists in ascertaining for any year the ratio between the deaths under one year of age and the registered births. For this purpose, an accurate registration of yearly births and of deaths under one is requisite.

The third method consists in establishing for each year, in the shape of a percentage, the ratio of deaths under one year, and under five years of age, to deaths at all ages, the only necessary data being the number dying in a year at all ages, and at the specified ages. This method affords a less precise measure of infant mortality than the two methods previously described, because it involves a comparison between two variable quantities. The ratios so obtained are very considerably affected by variations of age-distribution in the population concerned, and by variations in the mortality at other ages than those under special consideration. Still, in the absence of the data necessary for the use of the more accurate methods, which require either a careful census of the population, or an accurate registration of births, the yearly percentages of deaths under one and under five yield sufficiently trustworthy results for purposes of comparison. In many communities in the United States no other method is available, so imperfectly are the numbers of the living and of the yearly births ascertained and registered.

Variations of Infant Mortality.

A few statistical statements, derived from various sources, and relating to different countries and communities, will serve to exemplify the three methods of estimation which have just been described, and will also show the limits within which the mortality of childhood varies.

The mean annual death rates of infants under one, in some of the principal countries of Europe, have been stated by Dr. Farr[1] to be as follows: out of 1,000 infants there die yearly in Sweden, 141.8; in Denmark, 137.5; in England, 182.6; in France, 223.2; in the Netherlands, 237.5; in Spain, 249.6; in Italy, 273.3.

The annual death rates in 1,000 children under five, according to the same authority, were: in Norway, 40.9; in Sweden, 51.4; in Denmark, 52.7; in England, 67.6; in Belgium, 74.9; in France, 79.2; in Prussia, 82.4; in Holland, 91.2; in Austria, 104.0; in Spain, 111.7; in Italy, 113.5.

The yearly ratio of deaths under one to births in different countries is shown by Dr. Edward Jarvis[2] to have varied as follows: In Norway the

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[1] Mortality of Children in the Principal States of Europe. By Dr. William Farr: Journal of the Statistical Society, Vol. XXIX., pp. 30 and 35.

[2] Fourth Annual Report of the Massachusetts Board of Health, p. 196.

ratio was 10.71; in Scotland, 13.55; in Massachusetts, 13.91; in Sweden, 14.34; in England, 15.40; in France, 16.80; in Austria, 17.94; in Spain, 18.61; in Italy, 23.80; in the Netherlands, 24.17; in Austria, 25.19; and in Bavaria, 34.04.

The percentages of deaths under one and under five to deaths at all ages, calculated by Dr. Jarvis from the yearly vital statistics of a number of different populations, are exhibited in the following table :[1]

COUNTRY.	Ratio per cent. to deaths at all ages.		COUNTRY.	Ratio per cent. to deaths at all ages.	
	Under 1.	Under 5.		Under 1.	Under 5.
Massachusetts.....	19.43	36.61	Norway.........	18.82	33.33
Kentucky........	21.87	41.61	Prussia..........	21.25	47.52
South Carolina ...	23.31	45.59	Austria	30.39	49.96
Michigan.........	25.93	33.21	Holland	31.94	46.58
England	21.24	40.53	France..........	20.92	32.71
Scotland	19.35	37.96	Italy............	27.72	47.26
Russia...........	.....	52.60	Spain...........	18.61	38.46
Sweden	22.26	39.52			

The foregoing data have all related to aggregate populations, comprising both urban and rural districts. We will now give a few figures showing the prevalence of infant mortality in cities.

In London, during a period of ten years (1851–60), the deaths under five were 43.8 per cent. of all deaths. The death rate during the years 1861–70, among children under five, was 81.6 in a thousand; during the eight years following (1871–78) it was 73.8.

In Paris, according to Bertillon,[2] the mean death rate under one during four years (1862–66) was 290 per 1,000. In Berlin, during a period of fifteen years (1854–1868), over a third of all the deaths took place under one year of age. In 1872 the mortality under one was 310 per 1,000; in 1873 it was 320 per 1,000, the general death rate being 28.29. In 1872 deaths under one were 39.9 per cent. of all deaths, and in 1873 their percentage was 42.0.[3]

In New York, during seven years (1866–1872) the mean percentage of deaths under one was 30.5; that of deaths under five was 50.0. In Cincinnati, during seven years (1867–1873) deaths under one were 25.5 per cent. of all deaths; and deaths under five were 48.1 per cent. In 1869 deaths under five amounted to 51.0 per cent. In Cleveland, in 1873, the

[1] Fourth Annual Report of the Massachusetts Board of Health, p. 197.

[2] Démographie figurée de la France. Paris, 1874.

[3] Virchow: Berlin. klin. Wochenschrift, Dec. 9, 1872. Monatschrift für med. Statistik. Sept. and Oct.. 1874.

percentage of deaths under one, still-births deducted, was 29.5; and that of deaths under five was 49.1.

In Boston—which is by no means one of the unhealthiest cities of the United States, the mean general death rate not exceeding 24.5 in a thousand—the mean death rate under one year of age, determined in four census years (1855, 1865, 1870, 1875) was 272.7 in a thousand infants living of that age, and the death rate among a thousand children under five was 95.6.[1] That such high rates of infant mortality have not always prevailed in Boston is shown in the following table,[2] which exhibits the percentages of infant mortality during a period of 54 years.

Years.		Percentage of deaths under one to total deaths.	Percentage of deaths under five to total deaths.
Means of 10 years	1820–29	8.73	25.69
	1830–39	12.66	35.17
	1840–49	12.76	37.52
	1850–59	23.84	46.49
	1865–74	25.40	41.70
Means of 5 years	1865–69	23.9	41.3
	1870–74	27.0	42.1
Single years	1874	28.19	42.99
	1875	25.25	44.34
	1876	24.82	43.04
	1877	24.95	40.94

In marked contrast with the mortality of infants in great cities are the rates prevailing among rural populations. In the sixty-three "Healthy Districts" of England the mean annual death rate of children under five was only 40.34 in 1,000 living at that age; and in twenty-eight selected districts the rate was as low as 33.48.[3]

The foregoing figures serve to show how greatly the mortality of early childhood varies in degree in different localities. We will now pass to a more important part of our subject, namely, the nature and causes of the diseases which prevail in the early years of life, and we will lay special stress on those diseases of infancy which appear to be more or less amenable to prevention by sanitary agencies.

The Principal Diseases of Infancy—Their Nature and their Causes.

It must, at the outset, be acknowledged that any attempt to ascertain accurately the nature of the diseases which occasion the great mortality of infancy is surrounded with difficulties, owing not only to the inherent ob-

[1] Seventh Report of the Masschusetts Board of Health, p. 496.

[2] Constructed from figures given in the Yearly Reports of the City Registrar.

[3] Supplement to the 35th Report of the Registrar-General, p. xi.

scurity of the subject of infantile pathology in itself, but also, and perhaps chiefly, to the general prevalence of imperfect or inaccurate diagnosis and of careless registration. The diseases of infancy, as registered in different communities, and at different times, are apt to vary quite as much on account of different habits of diagnosis and different systems of nosology, as on account of differences in the nature of the diseases themselves. In very few communities, if indeed in any, are the causes of death accurately registered, and the shortcomings are chiefly apparent in connection with the diseases of infancy.

The most careful, elaborate, and comprehensive data relating to the causes of diseases prevailing in childhood are to be found in the records of the registrar-general of England. The following table,[1] constructed by Dr. Farr from the registrar's figures for the decenniad 1861–1870, shows the comparative degrees of prevalence of certain forms of fatal infantile disease in different classes of English communities:

TABLE

SHOWING THE NUMBERS DYING UNDER FIVE YEARS OF AGE OUT OF 1,000,000 CHILDREN BORN ALIVE, (1) IN THE HEALTHY DISTRICTS, (2) IN ALL ENGLAND, AND (3) IN THE DISTRICT OF LIVERPOOL.

	Healthy districts.	England.	Liverpool district.
Deaths from all causes	175,410	263,182	460,370
Total zymotic diseases	49,761	87,099	171,009
Small-pox	602	3,331	5,175
Measles	5,257	11,507	25,514
Scarlatina	11,373	17,959	26,818
Diphtheria	4,184	2,425	3,395
Whooping-cough	9,650	14,424	32,551
Typhus, typhoid, and common fevers	2,807	5,401	9,297
Diarrhœa and dysentery	9,354	20,344	51,911
Cholera	399	1,129	4,255
Other zymotic diseases	6,135	10,579	12,093
Cancer	110	71	62
Scrofula and tabes	5,335	8,115	11,694
Phthisis	2,656	4,469	5,116
Hydrocephalus	6,604	9,296	14,972
Diseases of the brain	22,692	40,065	49,840
Diseases of the heart, and dropsy	1,304	1,507	2,038
Diseases of the lungs	27,884	41,476	79,893
Diseases of the stomach and liver	4,431	4,778	4,874
Violent deaths	4,232	5,175	17,107
Other causes	50,401	61,131	103,765

[1] From the Supplement to the 35th Registrar-General's Report, p. xxix.

Dr. Farr, commenting on the causes of death among infants under one year of age, remarks that "to convulsions, diarrhœa, pneumonia, bronchitis, chiefly, their deaths are ascribed. . . . The first two are said by pathologists to be often rather symptoms of disease than diseases in themselves." . . . "In the second year of life," adds Dr. Farr, "pneumonia, bronchitis, and convulsions are still the prevalent and most fatal diseases; many also die then of measles, whooping-cough, scarlatina, and diarrhœa. Scarlet fever asserts its supremacy in the second, third, fourth, and fifth years of age. Whooping-cough is at its maximum in the first year, measles in the second, scarlatina in the third and fourth years. Thus these diseases take up their attacks on life in succession, and follow it onwards."[1]

In the United States, registration is very much less full and accurate than in England; and the data in relation to the diseases of infancy and childhood are of a very unsatisfactory nature. That such is the case is made evident from the following table[2] showing the proportionate mortality due to the various diseases of early life as commonly diagnosticated and registered in Massachusetts:

Causes.	Massachusetts, 1870. Percentage on all deaths under five.	Causes.	Massachusetts, 1870. Percentage on all deaths under five.
Diseases of brain.	1.38	Canker..........	1.33
Bronchitis........	1.02	Measles	2.03
Cephalitis	3.55	Infantile.........	4.76
Cholera infantum.	17.40	Pneumonia	6.85
Consumption	3.23	Premature birth..	2.52
Convulsions	4.80	Scarlet fever.....	7.14
Croup	4.14	Tabes mesenterica.	2.74
Debility.........	1.95	Teething	2.92
Diarrhœa........	2.57	Whooping-cough .	3.27
Diphtheria.......	1.57	Burns	0.55
Dysentery........	2.88	Casualty	0.25
Enteritis.........	0.94	Lung diseases....	0.29
Typhus fever.....	1.34	Scrofula	0.55
Hydrocephalus ...	4.57		

The registration of vital statistics has been longer established and more fully developed in the State of Massachusetts than in almost any other part of the country. Nevertheless this table will not serve so much to show the causes of death among children as to illustrate the careless and inefficient way in which registration is carried out by the medical profession of this country; for, out of all the so-called "causes of

[1] Supplement to 35th Report of the Registrar-General, p. xxviii.

[2] From Dr. Jarvis's paper on Infant Mortality, 4th Report of Mass. State Board of Health, p. 204.

death " therein specified, nearly half are quite devoid of any precise nosological significance.

In this country, as indeed elsewhere, a large proportion of fatal cases, in which death has resulted from various primary causes, are promiscuously registered under the headings of *teething* and *convulsions*. These designations are utterly unsatisfactory, inasmuch as they convey absolutely no idea of the real cause of death. Teething, on the one hand, is a physiological process, a phase of normal growth, which coincides, to be sure, with a period of danger to health and life, namely *weaning*, but which probably stands in no causal relationship to the diseases which may then prove fatal. It is safe to assert that the numerous deaths everywhere imputed to this imaginary cause are merely illustrations of inadequate diagnosis. Convulsions, on the other hand, are but a frequent epiphenomenon of serious or fatal infantile disorders. They generally occur either at the first onset of some acute disease,[1] whose ulterior symptoms do not have time for full development, or escape attention or recognition; or else they constitute the closing scene of antecedent disease of short or long duration. In such cases " convulsions " should no more be made to do duty in registration as the " cause of death " than *asphyxia by bronchial mucus*, which in adults is so often the ultimate phenomenon of disease and the direct mechanical cause of the cessation of life.

Taking into consideration, then, the comparatively valueless character of registration in connection with the causes of death among children, we must content ourselves with a somewhat rough classification of the principal diseases which take part in the production of infantile mortality.

These may be divided into the following four classes, comprising those disorders which prevail most extensively and cause the greatest loss of life among children:

1. *The acute infectious zymotics*, among which the most important by their frequent occurrence and fatality are the ordinary eruptive fevers (measles, scarlet fever, and small-pox), diphtheria, and whooping-cough.
2. *Inflammations of the respiratory organs*, registered chiefly under the headings bronchitis and pneumonia.
3. *Tubercular diseases and scrofula*, including cases recorded under the names of phthisis, tabes mesenterica, etc.
4. *The diarrhœal diseases*, which are registered, and, as will be shown farther on, often disguised, under a great variety of more or less correct designations.

We will now consider in turn, with special reference to their causes, each of the foregoing classes of disorders, laying stress chiefly on those forms of infantile disease which seem to be more or less preventable.

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[1] Dr. Radcliffe says that "in the fevers of infancy and early childhood, especially in exanthematous forms of these disorders, convulsion not unfrequently takes the place occupied by rigor in the fevers of youth and riper years." A System of Medicine, by Reynolds. Vol. II., p. 593.

Class I.—The Acute Infectious Zymotics.

The acute infectious zymotics which deserve special consideration on account of their widespread prevalence are the common eruptive fevers (scarlet fever, measles, and small-pox), diphtheria, and whooping-cough. These diseases, which contribute so largely to the general mortality of every community, are well known to be pre-eminently diseases of childhood. Dr. Farr's calculations show that the mean ages at death by these diseases were in England (1848–'70) as follows: whooping-cough, 1.8 years; measles, 2.7; scarlatina and diphtheria, 5.8 years; and small-pox, 11.9 years. In England during ten years (1861–'70) the deaths under five caused by these five diseases amounted to 18.8 per cent. of all deaths at that age. In Massachusetts, in 1870, a year when small-pox was not prevailing, the proportion of deaths under five so caused was 14 per cent. In Boston, in 1875, the corresponding percentage was much higher, over a quarter (26.7 per cent.) of all the deaths under five having been due to these diseases alone.

Of all the acute infectious diseases which occasion death in early life, *scarlet fever*, in consequence of its extensive and almost unremitting prevalence, is by far the most destructive. The mortality caused by this disease falls principally upon young children. In England, from 1861 to 1870, of all deaths under five, as many as 6.7 per cent. were due to scarlet fever. Dr. Murchison's statistics constructed from a total of 148,829 deaths from scarlet fever, which had occurred in England and Wales, show that 63.87 per cent. of all the fatal cases occurred under five years of age.[1] In Philadelphia, of all the deaths so caused during a period of forty-five years, nearly three-quarters (73.37 per cent.) were under five. Dr. Draper's analysis of the Registration Reports of Massachusetts showed that 67 per cent. of the deaths by scarlet fever occurred under the age of five years.[2] Thus we see that this is pre-eminently a disease of infancy and childhood. According to Dr. Farr, the years of life in which it most frequently proves fatal are the second, third, fourth, and fifth. These facts suffice to show how very large a part is played by the acute infectious diseases in the production of infant mortality, and how important it is that their dissemination should be restricted by all the available means of prevention.

The diseases now under consideration all have this feature in common, that they are transmissible by contagion, immediate or mediate, from sick persons to predisposed healthy subjects. In the causation of such diseases there are then two necessary factors to be considered, namely, the *predisposition* and the *contagion*, resulting from the exposure of a healthy subject to the specific poison of an infectious disease. The prevention of infectious disease rests upon our knowledge and control of both of these two orders of causes.

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[1] The Lancet, September, 1864, page 483.

[2] Paper on Scarlet Fever, by Dr. A. H. Johnson: Ninth Mass. State Board of Health Report, page 269.

Of the *predisposition* to infectious disease our knowledge is very slight and vague. We know it only by its result, which is *susceptibility* to disease; but we ignore wholly in what it consists, and we have only vague presumptions with regard to the conditions under which it exists. Some authorities are inclined to believe that unfavorable local conditions of soil, of drainage, and of water-supply, such as commonly prevail in poor and crowded districts, and are the origin of what have been called by the expressive name of "filth diseases," may be to a certain extent accessory causes of the general prevalence and occasional severity of certain infectious zymotics. These conditions, which appear to modify the intensity of such diseases in different individuals in different localities and at different times, probably exert their influence by increasing the predisposition of the exposed subjects to severe forms of disease rather than by bringing about any modification of the morbific poison itself. If this view be correct, there is reason to believe that sanitary measures directed against the more manifestly filth-begotten diseases, such as the diarrhœas and typhoid fever, especially such measures as aim at the purification of air, soil, and water in overcrowded urban districts, may also act favorably upon the acute infectious diseases which make so many victims among infants and children.

Against small-pox, as is well known, we possess in *vaccination* an invaluable means of prevention, which operates by annulling or attenuating the predisposition to the disease. In very few, if any, communities, however, is this precious resource so fully utilized as to yield its full measure of protection, and it is principally in the first years of life that the evil results of such neglect are apparent. Thus, in Boston, where a delay of two years from birth is allowed for vaccination, in the epidemic of 1872—which was by far the most severe outbreak that had been experienced since the introduction of vaccination—over a quarter (26.5 per cent.) of all the fatal cases of small-pox occurred in children under five, although the latter constituted only one-eighth of the entire population of the city; on the other hand, youths aged between five and fifteen years, making 18.5 per cent. of the living population, contributed only 5.8 per cent. of the deaths by small-pox.[1] These figures show the deficiency of protection in the first years of life, and the efficacy of vaccination practised later on in the ages of attendance at school.

Medical men are everywhere agreed that there is no conceivable reason why vaccination should ever be postponed beyond the first months, or even weeks, of an infant's life, and that at times of epidemic prevalence of small-pox the delay of even a few weeks is unadvisable.

The remedy for the neglectful delay or omission of vaccination is of course the *compulsory vaccination* of children, performed within prescribed limits of time, and enforced, under penalties, by public authority (boards of health). But although, as already said, no medical reasons

[1] From the Report of a Medical Commission on the Sanitary Condition of Boston, 1875, p. 93.

exist for allowing the performance of vaccination to be postponed beyond the first weeks, or even days, of an infant's life, nevertheless the expediency of so limiting the period allowed for compulsory vaccination must, in most communities, be doubtful. There is a danger in attempting too zealously to enforce early vaccination which must be guarded against —a danger, namely, of rendering a desirable sanitary measure intolerably vexatious, and of exciting among the ignorant and prejudiced an opposition which might in the end defeat the very object of the intended reform.

The limit of time to be allowed for the compulsory vaccination of infants and children, then, must vary with the degree of enlightenment of different communities; but it can be safely asserted that the period during which children shall be allowed to remain unvaccinated ought everywhere to be abridged to the greatest extent that may appear to be compatible with the general acquiescence of the public. It is to be hoped that public opinion may some day be educated to such a point in this particular matter that it may be possible, especially at the first outbreak of a new epidemic, to enforce vaccination within the first six months, at least, of every infant's life.

The prevention of *contagion* is undoubtedly attainable in a large measure by means of sanitary precautions, pertaining both to private and to public hygiene. The first means to be advocated, and, in so far as is possible, enforced by public authority (boards of health), is the *isolation* of the sick, at home or in hospitals. Another precaution of a similar nature consists in preventing attendance at school on the part of children who are affected with infectious diseases, or who are in any way capable of acting as carriers of contagion. Against the chances of mediate contagion the chief resource is a proper and adequate resort to the *disinfection* or *destruction* of all infected articles.

We will not dwell longer upon this subject, which has been fully treated elsewhere, but will sum up our remarks upon this class of the fatal diseases of childhood by saying that much preventable fatal disease at early ages is due to the reckless, almost wholly unrestricted dissemination of contagia, and to the neglect of early vaccination; and that in every community, but especially in all towns and cities, it is eminently desirable that the public authorities should be placed upon such a footing and so armed with the requisite powers as to be able to enforce among the ignorant, the careless, and the criminally neglectful members of the population the sanitary precautions which are known to be efficacious against the spreading of infectious disease.

Class II.—Inflammations of the Respiratory Organs.

Deaths caused by these diseases are registered under the headings of bronchitis, pneumonia, congestion of the lungs, œdema of the lungs, or simply "lung disease." These affections are known to be particularly frequent and fatal at the extreme ages of life. In England, according to

Dr. Farr's figures, diseases of the lungs cause nearly a sixth (15.7 per cent.) of all deaths under five. In London, of all deaths by bronchitis and pneumonia, nearly a half (44 per cent.) occur under five. In Massachusetts, 38.4 per cent. of the fatal cases of pneumonia take place under five.

The relative frequency of deaths ascribed to bronchitis and to pneumonia varies in different localities. Throughout England, deaths by bronchitis are more than twice as numerous as deaths by pneumonia. In Massachusetts, on the other hand, more than twice as many deaths are caused by pneumonia as by bronchitis.

The acute inflammations of the respiratory organs result from various causes. In a large proportion of such cases, where the disease is primary, the cause must undoubtedly be sought in exposure to wet and cold, resulting from lack of proper clothing, deficiency of fuel, and ill-constructed habitations. Hence, the great increase of deaths by bronchitis and pneumonia in the winter months. A careful analysis of the statistical records of our great cities shows that the ill effects of the cold season are chiefly felt among children over one and under five years of age. Many of the fatal cases of bronchitis and pneumonia undoubtedly occur as secondary complications or sequelæ of infectious diseases, particularly of measles and whooping-cough.

The prevention of these disorders relates to private rather than to public hygiene. The provoking causes just mentioned are obviously only in a slight degree removable, inasmuch as they are largely results of parental poverty, ignorance, and carelessness.

Class III.—Tubercular Disease and Scrofula.

The various forms of tubercular and strumous disease which occur in early childhood comprise cases registered and scattered under the following somewhat equivocal designations : phthisis, consumption, lung disease, tubercular meningitis, hydrocephalus,.cephalitis, disease of the brain, convulsions, tabes mesenterica, marasmus, scrofula, teething, debility, and "infantile." Cases of tuberculosis occurring in the first years of life are so often obscure, and the registered diagnosis is so liable to be mistaken or misstated, that it is scarcely possible to determine even approximately the degree of prevalence of these disorders. An examination of the figures contained in the Massachusetts Registration Reports shows that at least from 10 to 15 per cent. of all deaths under five must be attributed to this class of diseases. In great cities, where the conditions under which these forms of constitutional disease originate are much more prevalent than in rural districts, the proportion of infant mortality so caused must be much greater.

Disorders of this class almost invariably result from constitutional disease transmitted from consumptive or scrofulous parents to their children, and in proportion as the adult members of any population are liable to these diseases, in such proportion will the early forms of tubercular and

scrofulous disease prevail among their offspring. As regards the ages at which hereditary phthisis is developed in the successive generations of a family, it has been asserted[1] that when a man becomes consumptive at sixty years of age, his children die before reaching the age of forty, and his grandchildren in infancy or childhood; in other words, the manifestations of the inherited disease appear at earlier ages in each succeeding generation. Mr. John Simon says that "whatever tends to increase tubercular disease among the adult members of a population must be regarded as assuredly tending to produce a *progressive degeneration of race*." The effects of this physical degeneration are strikingly manifest in the lower classes of almost all great cities, and show themselves unmistakably in the form of tubercular and strumous diseases prevailing among infants and young children. Especially is this the case in densely populated manufacturing cities, where so many causes of physical deterioration combine to assail the working-classes.

In the peculiar conditions under which life is now maintained among the lower classes of great cities, harmful agencies can be shown to exist which seem to account in a large measure for the existence of high rates of infant mortality. There is in the present age a marked tendency toward the concentration of populations into large manufacturing and commercial centres. In these, as has been pointed out by De Candolle,[2] there is a great development of trades and callings, which require manual skill and intelligence rather than bodily strength, and which are not incompatible with physical debility. Hence, the creation of large and densely crowded urban populations, composed of skilful and intelligent, but often physically feeble artisans, whose avocations oblige them to lead sedentary and confined lives, and who are liable, in consequence of excessive competition, to be overworked, underfed, and ill-housed. Public charities and carefully organized medical assistance are provided for the most needy and unfortunate. All these favoring conditions combined enable the weaker individuals to get along in life and to marry, whence results the generation of a stock of congenitally feeble infants. It has thus been shown by De Candolle that in a high state of civilization, such as is attained in the great cities of the present age, conditions of life exist which actually reverse the ordinary processes of natural selection, and bring about the survival of the (physically) *un*fittest. These are enabled to live, to marry, and to procreate; but their offspring, inheriting feeble or diseased constitutions, are necessarily short-lived.

The only means of prevention which can be expected to counteract these deleterious conditions are those which serve to check the development of phthisis, tubercular disease, and scrofula, among adults. For this purpose all the resources of hygiene, both public and private, must be brought into play.

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[1] Prof. Natalis Guillot, quoted by Hérard and Cornil: De la phthisie pulmonaire. Paris, 1867, p. 569.

[2] Alphonse de Candolle: Histoire des sciences, etc., Geneva, 1873, pp. 368 to 373.

CLASS IV.—THE DIARRHŒAL DISEASES.

These, by reason of their very great frequency and fatality, are by far the most important of all the diseases of early life. To determine the precise extent of their prevalence in any community is impossible, so inaccurately are the diseases of infancy and childhood everywhere registered. Cases of fatal diarrhœal disease are recorded under a great variety of designations, among which the following may first be enumerated, as being the least equivocal: diarrhœa, cholera infantum, cholera morbus, enteritis, gastritis, gastro-enteritis, entero-colitis, inflammation of the bowels, dysentery, etc.

The amount of mortality ascribed to these forms of diarrhœal disease varies greatly in different localities; everywhere, however, the deaths so caused make a very large proportion of the total mortality at all ages. In England, according to Dr. Farr's figures, in the healthy districts, out of all deaths under five, the percentage of deaths ascribed to diarrhœa and dysentery was 5.3; in the country at large (England and Wales) it was 7.7; in Liverpool 11.3; and in Leicester it was as high as 17.3. The form of diarrhœal disease which is most prevalent in the United States, especially in the cities, is that which appears in registration under the name of *cholera infantum*. In the State of Massachusetts, the deaths attributed to this disease alone amounted during ten years (1866–1875) to 18.6 per cent. of all the deaths under five; in one year of exceptional fatality, in 1872, the percentage reached as high as 24.0.

But, although the aggregate of deaths recorded under these various headings make, as we have just seen, a very imposing total, representing in great cities of this country over a fifth of all the deaths under five years, they are far from representing the full measure of mortality attributable to infantile diarrhœa in all its forms. In the first place, many of the numerous deaths occurring in early life, which are ascribed to *marasmus*, are undoubtedly cases of summer diarrhœa, more or less disguised by a subacute or chronic course and a prolonged duration. The real nature of such cases may be recognized from the fact that a majority of the deaths registered as marasmus occur in the summer and autumn months. In the next place there is reason to believe that, in many cases of death resulting from infantile diarrhœa, an erroneous and misleading diagnosis of the "cause of death" is made and recorded. To substantiate this assertion, we must refer our readers to a work of the highest value,[1] recently published by Prof. Parrot, of Paris, in which quite novel views in relation to the nature and nosological significance of the diarrhœal diseases of infancy are set forth. No summary of Prof. Parrot's ideas, unsupported by the clinical and pathological basis upon which they rest, can suffice to convince the reader of their value and significance. We will nevertheless try to set forth, as briefly as possible, the leading points of the broad generalization by which Prof. Parrot reduces to a clear and

[1] Clinique des nouveaux-nés. L'Athrepsie: J. Parrot, Paris, 1877.

simple nosological conception, an incoherent assortment of morbid derangements, whose common origin and mutual relations had been unobserved, and whose real nature and significance had been misunderstood.

In cases of prolonged digestive disturbance, occurring in infancy, there is often a series of diverse symptoms and complications, each of which is liable to be looked upon as a disease in itself, although they in reality constitute so many successive pathological phases in the evolution of one primary disease. The latter—for which Prof. Parrot proposes the name of *athrepsia*, from α, privative, and θρεψις, nutrition—whether acute, subacute, or chronic in its course, is always essentially one and the same disease. From an etiological point of view, it has an unequivocally characteristic feature, which is, so to speak, its stamp: the disease invariably results from an inadequate or unsuitable diet, occasioning derangements of digestion and nutrition. Pathologically, its distinguishing feature is a progressive denutrition, or wasting of the entire organism, *totius substantiæ*, resulting in emaciation, anæmia, and visceral steatosis. As regards its symptoms, it is characterized by a constant initial manifestation, namely diarrhœa, which, in the most sudden and acute forms (cholera infantum), may be at once the beginning and the end of the disease. In subacute and chronic cases, this initial diarrhœa, constituting what Parrot calls the gastro-intestinal phase of the disease, is succeeded by a series of disturbances, consisting chiefly of phenomena of denutrition, and by various secondary manifestations and complications resulting from the various organic alterations which ensue.

The manifold disturbances and alterations occurring as separate symptoms or complications of the disease called athrepsia, comprise: diarrhœa, thrush (or canker), erythema, ulcerations of the skin and mucous membranes, otitis interna, sclerema (or induratio neonatorum), coma, convulsions, trismus. These, together with certain of the local alterations incidental to the general disease, are described by authors, in so many separate chapters, as so many distinct morbid entities; and each is liable to afford to the practitioner a distinct diagnosis, supplying the "cause of death" in registration. From this nosological confusion results the multiplicity of designations resorted to in such cases. Some of the terms used in diagnosis and in registration, although nosologically incorrect or unsuitable, are nevertheless sufficiently characteristic of the primary disease to allow its real nature to be recognized. Such are the cases in which death is ascribed to some form or other of digestive derangement. Some of the other designations are more misleading, but are yet capable of correct interpretation. Thus, fatal cases of thrush and of trismus nascentium can with little hesitation be ascribed to infantile diarrhœa, with a strong presumption that the latter was the primary disease. There are, however, undoubtedly a large number of cases of death by athrepsia which go on record under some more or less vague designation applying to one of the accessory symptoms or complications of the disease, and such cases are thereby so disguised as to be no longer recognizable. A majority of the cases registered under the heading of *convulsions* are probably cases of

uræmic eclampsia (*encéphalopathies urémiques* of Parrot) occurring at the termination of athrepsia, the initial manifestations of the primary disease having been unobserved or forgotten. The rest of such cases of "convulsions" are instances of unrecognized febrile diseases, eruptive fevers, etc. These remarks apply also to cases recorded as "disease of the brain," of which a great proportion should undoubtedly be referred to athrepsia as the primary disease. Such is also the case with a number of instances in which death is ascribed to some vague or meaningless "cause of death," such as: *debility*, *premature birth*, *imperfect development*, *meningitis*, *hydrocephalus*, *paralysis*, *consumption*, etc. Finally, certain deaths ascribed to pneumonia are in reality due to athrepsia, pneumonia being, according to Parrot, one of the most frequent complications of that disease.

Athrepsia, as described by Parrot, occurs in two principal forms, the rapid or acute, and the slow or chronic form. The acute form sets in suddenly with severe symptoms, after a few days of preliminary diarrhœal disturbance. The temperature rises, and remains high. Death ensues in a few days. In some of these cases, occurring in the hot season, the onset is extremely sudden and violent (*forme foudroyante*), and the choleriform or cyanotic form of rapid athrepsia is observed, a type which answers to the disease so familiar in American cities under the name of cholera infantum. In the chronic form, the disease establishes itself insidiously. The first symptom is diarrhœa, followed by frequent vomiting. The daily losses so caused increase; the ingesta become less and less, till finally food is refused; the weight and size of the body decrease; the temperature falls; the blood-corpuscles become fewer. Various complications ensue (thrush, erythema, ulcerations of the skin and mucous membranes, otitis). Finally death takes place, often preceded by convulsions, or trismus. The post-mortem examination reveals the existence of numerous alterations, among which the most frequent and striking are lesions of the brain (steatosis, softening, hæmorrhage), lesions of the kidneys, lesions of the lungs (steatosis, emphysema, pneumonia).

In the disease thus described under the name of athrepsia, we have a new nosological conception, in which the bond of a common etiology unites a diversity of hitherto separate affections and complications. These are shown to be etiologically one, having a common source in the same initial disturbance, namely, in the denutrition which results from an insufficient or unsuitable diet. The value of the new morbid entity so conceived lies in this, that it brings together and co-ordinates a number of scattered, incoherent elements of infantile nosology, and thereby affords a clue by which we may be better enabled to interpret the hitherto hopelessly obscure records of infant mortality; and that it subordinates all the secondary manifestations and complications to a distinct primary disease, whose mode of origin and whose causes are clearly set forth.

If now we examine the existing records of infant mortality, in all their imperfection, by the light of these ideas, we cannot fail to perceive how greatly the field occupied by the diarrhœal diseases of early childhood is

enlarged. In many localities, as, for instance, in Massachusetts, the mortality commonly ascribed to the various forms of diarrhœal derangement amounts each year to nearly a quarter of all deaths under five, cholera infantum alone representing not far from a fifth (18.6 per cent. from 1866 to 1875; 24.0 per cent. in 1872) of the deaths under five. An approximative estimation of the additional deaths, attributable to unrecognized cases of athrepsia classed under the misleading headings of canker or thrush, convulsions, trismus, disease of the brain, cephalitis, marasmus, tabes mesenterica, inanition, debility, teething, pneumonia, etc., so swells the aggregate mortality by diarrhœal disease as nearly to double it. Deaths under five make from 35 to 50 per cent. of all the deaths in our cities; and deaths under one make from 20 to 25 per cent. It can hardly be an exaggeration to say that of the former, nearly a half, and of the latter, fully three-quarters, are caused by athrepsia in its several forms.

Let us now pass to the examination of the conditions under which the diarrhœal diseases of infancy occur, with a view to determining their causes and the available means of prevention.

TABLE

OF AGES AT WHICH THE DEATHS OF THOSE OF FIVE YEARS OF AGE AND UNDER OCCURRED.

Ages.	No. of living children.	No. of deaths.	Death-rates per 1,000.
1 month and under	799	633	792.24
1 " to 2 months and under.....	783	273	346.69
2 months to 3 " "	886	192	216.70
3 " 4 " "	760	150	197.36
4 " 5 " "	712	163	228.93
5 " 6 " "	876	154	175.79
6 " 7 " "	760	143	188.94
7 " 8 " "	753	129	171.31
8 " 12 " "	7,657	514	67.12
1 year to 2 years "	8,498	835	98.25
2 years to 3 " "	7,626	429	56.25
3 " 4 " "	6,941	330	47.54
4 " 5 " "	6,885	222	32.22
5 years and under	43,936	4,167	94.84

Etiology.—*Age* stands foremost among the predisposing causes. The maximum frequency of the fatal forms of diarrhœal disease is during the first weeks of life; cases becomes less frequent after the lapse of the first year; and after two years of age, when the perils incidental to change of food are passed, these diseases are much less common. The very destruc-

tive form called cholera infantum seems to be quite strictly limited to infants of the nursing age. According to Meissner,[1] it does not occur after the completion of the first fifteen months of life. The table [2] on preceding page, constructed by Dr. W. L. Richardson from data relating to the city of Boston in the census year, 1875, shows the mortality by all causes, among infants and children during the first months and years of life. From these figures the decreasing fatality of the diarrhœal diseases during the first two years of life can be inferred.

Other predisposing causes, which favor the development of athrepsia, by rendering the infant unable to obtain sufficient nourishment, are premature birth, congenital weakness, malformations of the mouth preventing nursing, and certain inflammatory affections, such as pneumonia, erysipelas, peritonitis, etc. Even so apparently trifling a disease as a coryza may, as is shown by Parrot, prove fatal in the first weeks of life, occlusion of the nostrils making it impossible for the infant to suck the breast sufficiently to sustain life.

Locality causes great variations in the prevalence of infantile diarrhœa. Summer diarrhœa among infants is well known to be almost exclusively an urban complaint. Moreover, those cities are found to be most severely visited by this disease which are most densely populated. The manner in which density of population affects the death rate at all ages and the death rate among young children, the latter being increased in a much greater degree than the former, is strikingly shown in the following table, constructed by Dr. Farr : [3]

TABLE

SHOWING RELATION BETWEEN DEATH RATES AT ALL AGES, AND UNDER FIVE, AND DENSITY OF POPULATION IN A SERIES OF ENGLISH DISTRICTS.

Death rates, all ages.	Death rates under five.	Density. Persons to one square mile.
16	37.80	166
19	47.53	186
22	63.06	379
25	82.10	1718
28.5	95.04	4499
32	111.90	12357
39	139.50	65823

If we take into consideration the great predominance of diarrhœal disease among the causes of death in early life, we cannot avoid the infer-

[1] Volkmann's Clinical Lectures: Cholera Infantum, by E. A. Meissner, Leipzig, 1878.

[2] Paper on Infant Mortality : Fourth Report of the Boston Board of Health, 1876, p. 53.

[3] Supplement to Thirty-fifth Registrar-General's Report, p. clix.

ence that overcrowding of the population is one of the factors upon which its prevalence, on a large scale, in a locality chiefly depends.

Hospitals, and charitable institutions of all kinds, in which large numbers of young infants are collected and cared for, are almost invariably the seats of an excessive mortality. A special, not to say specific, morbific influence has been supposed to become developed in such institutions. Parrot, while recognizing the existence and the destructiveness of such a nosocomial influence, is of the opinion that its disastrous effects upon infant life are simply results of the common and familiar pathogenetic conditions which everywhere underlie the production of athrepsia.[1] In charitable institutions the laws of infant hygiene are apt to be ignored or neglected, the results being only such as might in every case be foreseen and prevented.

Influence of season.—Urban districts, even when most densely populated, do not suffer at all times from the severe forms of infantile diarrhœa, for the production of which another condition is necessary, namely, a high temperature. The intimate connection existing between summer-heat and cholera infantum is such that in New England the disease is hardly known to occur except during the summer months; cases then take place during a few weeks in such numbers as to raise the general mortality to higher altitudes than are attained in any other season. It is owing to this circumstance that the maximum of our general yearly mortality occurs in summer, whereas, in more temperate and more equable climes, as in England, the maximum mortality of the year occurs in winter. In New England the general death rate offers two maxima in the course of the twelvemonth, the higher of which occurs in the hottest weeks of the year, and is manifestly due to the prevalence of cholera infantum, while the other takes place in the coldest season. This second and lower maximum is the counterpart of the English maximum, and is due to the same cause, namely, to the prevalence of inflammatory affections of the respiratory organs occasioned by cold and damp weather. The winter season is much more severe in New England than in England, and its influence would be much more apparent in our monthly records of mortality, were it not dwarfed by the still greater destructiveness of our hot season. Harsh as our winters are, they are far less destructive to life than our scorching summers.

Similar effects are probably observed in all countries where the climate resembles that of New England in the alternation of very hot and very cold seasons. Virchow's figures show that Berlin resembles the cities of North America in the distribution of deaths throughout the months of the year; infants under one there supply over a third of all the deaths, and the maximum mortality occurs in summer.[2]

In the cities of North America the effect of the invasion of high temperature is each year the same, the mortality varying, however, in propor-

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[1] Loco citato, p. 379.

[2] Berlin. klinische Wochenschrift, Dec. 9, 1872.

tion to the intensity of the heat. In moderately hot summers (1867, 1871, 1873) the mortality under one in Boston is doubled or tripled during the hottest month, while the mortality from one to five is increased by half, or, at most, doubled. In a very hot summer month, on the other hand (July, 1872), deaths under one are suddenly almost quadrupled, the deaths from one to five being barely doubled. Thus, we see that the destructive influence of excessive heat is felt much more acutely during the first year of life than subsequently, while the reverse is noticeable with regard to the influence of winter cold, which tells severely upon children who have passed the age of one year.

The following table, relating to the city of Boston, shows the influence exerted by the variations of summer-heat upon the diarrhœal mortality, the most striking example thereof being afforded by the figures relating to the year 1872.

Years.	Temperatures at Cambridge Observatory.		Diarrhœal diseases.	
	Mean temp. ° Fahr. July and Aug.	Mean temp. during the hottest month.	Death rate per 1,000 living.	Percentage to all deaths.
1867	69.8°	70.4°	2.55	9.20
1868	71.6°	73.6°	3.10	13.20
1869	69.2°	70.8°	2.69	11.44
1870	72.3°	72.9°	3.63	14.92
1871	70.8°	70.9°	....	11.29
1872	71.9°	73.1°	4.10	13.41
1873	69.4°	71.6°	3.29	11.71
1874	68.6°	71.5°	2.70	11.32
1875	70.8°	71.3°	3.36	12.80

The facts observed in New York, in 1872, were very striking. The months of August and September were not very hot, but the mean temperature of July was 79.57°, being greater by 3.43° than that of the corresponding month during the previous ten years. In consequence of this one month's excessive heat, the summer quarter of 1872 proved to be the most fatal ever known in New York. During the quarter, deaths under one amounted to nearly three-fifths (59.33) of all the deaths, and of the total mortality under one for the whole year, as much as 40.8 per cent. took place during the three summer months alone. Of all the deaths in the year, numbering 32,647, as many as 5,197, or 15.9 per cent., were due to diarrhœal diseases. Of these deaths, 3,542 occurred under one year of age, making over 10 per cent. of the entire mortality of the year.[1]

The foregoing statements relate principally to cholera infantum, as observed in a particularly severe climate. The same destructive influences

[1] Third Annual Report of the New York Board of Health, 1873, pp. 106 and 164

are recognized in more equable climates, such as that of Paris, as is shown by the etiology of athrepsia: "It occurs," says Parrot, "in all seasons, but it is certain that it is particularly frequent during the hottest months, as in June, July, and August; and that it then assumes a very exceptional degree of severity. Often I have seen infants who were till then in good health, as well as others previously sick, but whose approaching death was quite unexpected, be suddenly struck down (*foudroyés*) by a day of thunderstorms."

Influence of diet.—We have seen that the most fatal form of diarrhœal disease (cholera infantum) occurs in infants of the nursing age, less than sixteen months old, under the influence of two conditions, namely, urban density of population and extreme summer-heat. Neither of these two conditions by itself suffices to generate the disease, for cholera infantum, on the one hand, does not prevail to any appreciable extent in rural districts even during the hottest weather; and, on the other hand, it is not observed in the most crowded cities during cold or cool weather. We have now to consider the influence exerted by another cause of infantile diarrhœa, perhaps the most important of all, namely, unsuitable food.

It may, we think, be stated, as a proposition upon which all competent observers are agreed, that the most suitable food for infants is breast-milk;[1] and that, in default of this, the natural aliment of the new-born child, the only tolerable substitute is the milk of some animal, preferably of the cow, freshly drawn and suitably administered. Let us now see what are the results of departing from the plain hygienic law thus briefly enunciated.

Cholera infantum, says Meissner, one of the most recent writers on the subject we are considering, attacks only those children who have been raised without breast-milk, those who have been weaned too early and too hastily, or those to whom, on failure of the mother's milk, other food has been injudiciously administered. Under other circumstances than these, infants enjoy a complete immunity.

Parrot, rehearsing the etiology of athrepsia, says that "vicious ingesta constitute the most frequent and potent of all the determining causes." The food of the infant, he shows, may be harmful by its quantity and by its quality. A superabundance of breast-milk is rarely or never a cause of disturbance. Cow's milk, however, administered by means of a bottle, is liable to be swallowed too fast and in unduly large quantities, whence arises indigestion, followed by diarrhœa and vomiting. An insufficient supply of breast-milk rarely, if ever, causes digestive disturbances, the state of inanition occasionally referred to this cause being almost invariably due to some defect in the quality of the infant's food. Occasionally the milk of the mother or of the nurse disagrees with the nursling; diarrhœa sets in and persists until a new nurse is obtained. The milk which causes athrepsia is, however, rarely breast-milk, but cow's milk administered in a nursing-bottle. This way of feeding infants is particular-

[1] See Infant Diet, by Prof. A. Jacobi, New York, 1874, p. 9.

ly deleterious when the milk is deteriorated, whether by admixture or by not being fresh. The ill-effects so caused are much more rapid and severe in cities than in the country. "It may seem superfluous," adds Parrot,[1] "since we are speaking of new-born infants, to mention the harmful effects produced by other articles of food than milk, since such should be rigorously proscribed from their diet. But, unfortunately, infractions against this most natural law of hygiene are more common than one would imagine, and are responsible, in a great number of cases, for the initial disturbances of athrepsia."

Dr. J. L. Smith, in his well known treatise on the Diseases of Children, describes in so many chapters three forms of infantile diarrhœal disease, under the following names: non-inflammatory diarrhœa, intestinal inflammation of infancy, and cholera infantum. In the etiology of each form in succession, the use of improper food plays the most important part. Of cholera infantum he says that "atmospheric heat and its depressing influences are their predisposing causes, while the use of indigestible or irritating food is the exciting agent. Infants upon whom both causes are operative are most liable to cholera infantum in its severe form. Hence, bottle-fed infants of the city are especially liable to it, and infants whose food is carelessly and improperly prepared." [2]

The commission appointed by the House of Commons[3] to investigate the causes of undue mortality among infants, states in the "Report on the Protection of Infant Life" that "the ordinary mortality among infant children under one year of age is estimated at 15 or 16 per cent.; but the mere fact of their being hand-nursed instead of being breast-nursed will, unless great care is taken, raise the death rate, even in well conducted 'Homes,' to 40 per cent. and upward. In the inferior class of homes, where the children put out to nurse are, for the most part, illegitimate, the death rate may be 40 to 60 per cent. in the rural districts; and in the larger towns, where the sanitary conditions are more unfavorable, it mounts up to 70, 80, and even 90 per cent."

The superiority of breast-milk, the natural aliment of the infant, over all other foods being universally admitted, the question arises to what qualities is its superiority due? Attempts have been made to demonstrate that the milk of the human breast, is, by its chemical constitution, better adapted than any other milk to the requirements of the new-born infant. It has been pointed out that it contains less nitrogenous matter (casein) and more of the hydrocarbons (sugar of milk) than cow's milk. It has also been shown that the casein of cow's milk differs in quality, as well as in quantity, from that of human milk, in that, when coagulated by the gastric juice, it yields a harder, more bulky, and less soluble curd than the latter. According to Biedert,[4] cow's milk contains 4 per cent.

[1] Parrot: Loco citato, p. 384.

[2] J. Lewis Smith: Diseases of Children, New York, 1876, p. 638.

[3] Report on the Protection of Infant Life, 1871, p. v.

[4] See Biedert: Archiv für pathol. Anat. und Phy., Vol. LX., pp. 353 and 379. Parrot, loco citato, p. 434.

of a casein which is only half as digestible as that contained in the proportion of 2 per cent. in human milk.

The above-mentioned differences of composition existing between the milk of the human breast and that of animals do not, however, at all suffice to account for the disastrous effects produced, under certain circumstances, by the latter when used as food for infants. It is a well known fact that bottle-fed infants, raised on cow's milk, generally thrive in the country, when otherwise properly cared for, and that it is only in summer, in crowded urban districts and among the lower classes, that such fatality attends the artificial feeding of infants. There must, therefore, be some other reason, besides the chemical composition and physical qualities of human breast-milk, to account for its great superiority over all other foods for infants.

The explanation of the harmfulness of animal milk as food for infants is to be found in the alterations which the milk is liable to undergo between the time when it is drawn and its administration to the infant. This opinion has been gaining ground of late years, and finds support in recent investigations into the nature and origin of the phenomena of putrefaction.

It has long been recognized that diarrhœal disease owes its prevalence to *infection by filth.* "Nothing in medicine," says Mr. Simon,[1] "is more certain than the general meaning of high diarrhœal death-rates. The mucous membrane of the intestinal canal is the excreting surface to which nature directs all the accidental putridities which enter us. Whether they have been breathed, or drunk, or eaten, or sucked up into the blood from the surface of foul sores, or directly injected by the physiological experiments, it is there that they settle and act. As wine 'gets into the head,' so these agents get into the bowels. There, as their universal result, they tend to produce diarrhœa—simple diarrhœa, in the absence of specific infections; specific diarrhœa, when the ferments of cholera and typhoid fever are in operation. And any such distribution of diarrhœal diseases as has just been noticed warrants a presumption—indeed, so far as I know, a practical certainty—that in the districts which suffer the high diarrhœal death rate, the population either breathes or drinks a large amount of putrefying animal refuse." Let us now inquire how, and by means of what vehicle, filth-infection reaches the infant so as to occasion diarrhœal disease.

Milk, when exposed to atmospheric air, is known to be pre-eminently putrescible. So liable is it to become contaminated by the development of various ferments, that Prof. Lister[2] has used it as a substitute for Pasteur's solution in his experimental investigations into the subject of fermentation and putrefaction. "Milk," he says, is a "pabulum for all kinds of organisms; nearly all varieties of bacteria (and there are indeed

[1] General Board of Health: Introductory Report by the Medical Officer, London, 1858, p. xi.

[2] See a paper on Lactic Fermentation, by Prof. Lister: The Lancet, Dec. 22, 1877, p. 918.

very many varieties) will live in milk; whereas only a small proportion of such organisms will live in Pasteur's solution." Not only is milk very prone to decomposition, but it is exceedingly difficult to disinfect it, when once it has begun to undergo fermentative or putrefactive changes, in consequence of the access of organisms.[1]

Certain researches made by Baginsky[2] are of interest in this connection. He made a series of comparative experiments, for the purpose of ascertaining the degrees of putrescibility of various articles of infant food, comprising woman's milk, cow's milk, Swiss milk, and two kinds of farinaceous food. These, having been previously boiled, were exposed to a continuous temperature of 37° C. "After twenty-eight hours' exposure to this temperature, the woman's and cow's milk remained almost unchanged; but the Swiss milk, although appearing fresh, and the two artificial foods, exhibited bacteria in active motion. The woman's milk was alkaline, the cow's milk slightly acid, and the farinaceous foods were strongly acid. After a further exposure of eighteen hours, the cow's milk and the Swiss milk were coagulated, and the farinaceous foods in a high state of putrefaction; the woman's milk remaining still alkaline, and almost unchanged. The experiments were repeated many times and always with the same results. They were also varied, and it was found that, by careful manipulation and the use of distilled water, these changes might be delayed; but, for all practical conclusions, the first series of experiments holds good. The pre-eminence of human milk is acknowledged; then comes cow's milk, and then Swiss milk; and only at a far-off distance the farinaceous foods experimented upon can be admitted, not as substitutes, but as mere supplementary substances, which are rendered less mischievous by the addition of milk." Baginsky's investigations were undertaken with a view to ascertaining the causes of the prevalence of infantile diarrhœa in Berlin, and he came to the conclusion that the disease was chiefly due to the use of improper food.

Meissner, who asserts, as we have seen, that cholera infantum never attacks infants raised wholly upon breast-milk, is a determined advocate of the bacterial theory of diarrhœal infection. He expresses his conviction that the agency which, in midsummer, in densely populated districts, occasions fatal diarrhœa, does not reside in the animal milk *per se*. The pernicious agent, he says, must be sought solely in the alterations of the drawn milk resulting from the access of atmospheric air, and from the imperfect cleansing of the vessels in which the milk is kept and transported, and of the bottles, tubes, and mouthpieces through which it is administered to infants. He even goes so far as to assert that the same disastrous results ascribed to artificial feeding would ensue were human milk, drawn from the breast and transported to a distance, served to the

[1] See a paper on Disinfection, by Dr. E. B. Baxter: Medical Times and Gazette, May 12, 1877, p. 513.

[2] Baginsky: Berliner klinische Wochenschrift, Feb. 21 and 28, 1876; also Medical Times and Gazette, April 15, 1876, p. 425.

infant in nursing-bottles, like cow's milk, instead of being sucked from the breast; while, on the contrary, the use of cow's milk would not occasion cholera infantum, were it sucked by the infant directly from the teat of the cow.

The most recent testimony in favor of the view that diarrhœal disease results from putrefaction of the *ingesta* is to be found in a paper lately read before the Epidemiological Society, by Dr. William Johnson, of Leicester, in England. He therein expresses his belief that diarrhœa, as it affects both adults and infants during the summer months, owes its origin, in the majority of cases, to the introduction of living fungoid organisms into the system by means of air and water, and that the disease depends upon putrefactive changes in the bowel-contents which are correlative to the development and multiplication of the microscopic organisms.[1]

The foregoing considerations point to the conclusion that the harmfulness of certain articles of food (including cow's milk), which are widely used as substitutes for breast-milk, and which are known to play an important part in the generation of infantile diarrhœa, does not depend upon the recognized fact that they are less digestible than breast-milk, but rather upon their marked liability to undergo early and rapid decomposition.

Defective drainage and sewerage.—The association existing between uncleanliness and diarrhœal disease has long been a familiar fact in sanitary science. "Of diseases distinctively due to filth, the most characteristic," says Mr. Simon,[2] "are the diarrhœal." Dr. William Johnson, in the course of his investigations into the causes of summer diarrhœa in Leicester, has emphatically called attention to the evil influence of imperfect sewerage upon infant-life. "Charts were exhibited, indicating the distribution of the diarrhœal deaths in Leicester during the epidemic of last summer. From these it was seen that there was a special incidence of the disease in those districts of the town where the sewers were found to contain deposit. Dr. Johnson observed that those towns which possess sites admitting a considerable fall of their sewers have a very low death-rate from the disease under consideration, but that for those towns possessing sites which do not admit of their sewers having a good fall, the opposite is true, and this irrespective of their industries."[3]

The question now before us is to determine how this agency of filth infection operates to produce fatal diarrhœa in young infants. Some light is perhaps thrown on the subject by the contrast to be found in *rural* and *urban* forms of filth, considered in relation to their respective modes of infection, and to the resulting diseases. In rural and urban districts alike, uncleanliness consists in the non-removal of excreta and

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[1] Paper on the Etiology of Autumnal Diarrhœa, by Dr. Wm. Johnson: Medical Times and Gazette, January 11, 1878, p. 52.

[2] Filth Diseases and their Prevention: by John Simon, M.D., F.R.C.S.: printed under the direction of the State Board of Health of Massachusetts, Boston, 1876, p. 22.

[3] Medical Times and Gazette, Jan. 11, 1879, p. 53.

refuse matters of all kinds, but the results differ considerably in town and country. In the country, the air undergoes little or no permanent contamination; the drinking-water, on the other hand, is liable to become filthy, in consequence of the imperfect separation of sewage and water-supply which is characteristic of rural habits. The incoming and the outgoing household waters are liable to become mingled, and filth-infection takes place. The resulting disease chiefly takes the form of typhoid fever; hence, the greater frequency of this disease in rural as compared with urban districts. In cities, on the other hand, the conditions are very different. Here the water-supply is generally pure, being brought from a distance and sedulously preserved from contamination by sewage. But the air is impure; especially is this the case in densely populated districts, where, the houses being high and the streets narrow, the sun rarely penetrates and ventilation is imperfect. When to these already unfavorable conditions are added the effects of an inadequate provision for the removal of the various excreta of a superabundant and unclean population, the result is that the air is permanently laden with foul matters, comprising effluvia from the skins and lungs of the inhabitants, noxious vapors and gases from sinks, gutters and soil-pipes, and, worse still, excremental molecules from choked-up privies, drains, and sewers. Air reeking with these filthy matters requires only the ripening action of midsummer heat to be kindled, as it were, into a blaze of poisonous putridity. When all these conditions are fulfilled, miasmata are generated which seem to concentrate their noxious influence chiefly upon very young infants.

The manner in which this morbific influence is exerted, with the effect of producing severe diarrhœal disease, does not seem to us to admit of any doubt. In such surroundings as have just been described, all the conditions are combined which favor the rapid putrefaction of animal matters exposed to the access of the air. The articles of food used in the artificial feeding of infants are all known to be of a highly putrescible character. In midsummer, in poor, crowded, and ill-drained urban districts, under the combined influences of excessive heat and of contamination by filth, this tendency is aggravated to such a degree that the infants' food, when of an unsuitable nature—composed perhaps of stale milk, ill-kept and ill-served—is actually in a putrescent state when swallowed.

It appears probable, then, that the poisonous miasmata which are evolved from urban filth under the influence of high temperatures do not exert their universally recognized noxious action upon the infant directly by inhalation, but indirectly through the intermediate instrumentality of putrescible articles of diet. The injurious agent by which this particular form of filth-infection takes place is rotten food taken into the stomach, rather than foul air taken into the lungs.

Let us now sum up the facts relating to the causes of infantile diarrhœa which may be considered as demonstrated, and see if, from such data, any theory can be deduced which may account for the generation of the disease.

The most severe forms of diarrhœa—such as go by the name of cholera infantum, or summer diarrhœa—prevail on a large scale almost exclusively

under the following conditions: 1. During very hot weather. 2. In the poor and crowded districts of ill-sewered or unsewered cities. 3. Among hand-nursed infants of the nursing age. No one of these conditions suffices by itself to produce the disease, the combined action of all three being indispensable.

Diarrhœa is known to be the most common result of all putrid infections. In cases of severe diarrhœal disease, the bowel-contents themselves are found to give evidence of abnormal putrefactive changes taking place in the intestinal tract. The food which proves deleterious when administered to infants is eminently liable to undergo putrefaction. The other conditions relating to temperature and to filthy surroundings, in the absence of which severe diarrhœal disease does not occur, are manifestly such as to favor the development of putrefactive changes. It is therefore inferred that infantile summer diarrhœa results from filth-infection of which the vehicle is the food administered to the infant.

According to this view, the generation of summer diarrhœa is always due to a single pathogenetic agency, namely, the ingestion of decomposed food, this contingency being itself dependent upon a combination of conditions, each of which separately has long been recognized as deleterious to infant life. This theory seems to explain the pathogenesis of cholera infantum in a simple and at the same time comprehensive manner. It recognizes and includes, as so many concurrent factors contributing to a common result, the various morbific agencies incriminated as predisposing or exciting causes of diarrhœal disease. It conciliates and confirms rather than supersedes the diverse ætiological views previously entertained. It meets all the exigencies of the problem involved in the causation of cholera infantum in a more satisfactory manner than any other theory that has been brought forward.

To conclude our remarks on the causes of infantile diarrhœa, it still remains for us to touch briefly upon certain conditions which play an important part in the ætiology of the disease, chiefly, it must be said, by bringing into play and favoring the morbific agencies described above.

Illegitimacy is known to render the life of infants extremely precarious. The investigations of the commission appointed in 1871 to examine into the mortality of illegitimate children in England showed that, the proportion of illegitimate to legitimate children born in that country being on an average from 60 to 70 per 1,000, not more than 10 per cent. of these lived to grow up. The causes of this excessive mortality among the children put out to nurse were shown to be chiefly hand-nursing, among other forms of neglect, resulting from the poverty, ignorance and indifference of the mothers.

Poverty tells severely upon infants, notwithstanding the limited number of their requirements, which comprise only suitable food, clothing, pure air, and cleanliness. Often, in consequence of inability to gain a subsistence, due to lack of thrift and intelligence, or to physical disability, or to lack of work; often, too, in consequence of habits of intemperance, causing wages to be spent in drink, the father cannot earn enough to

maintain his family. Then the mother herself has to labor; and the exigencies of her work take her away from the care of her child, and prevent her more or less completely from nursing it. Attempts are then made to replace or supplement the lack of breast-milk by cheap and convenient modes of artificial feeding, with such disastrous results as have been described.

Intemperance on the part of parents enhances the poverty of the household by the waste of resources which it entails, as well as by the physical disability and ill-health which it causes; and so impairs the vitality of the entire family, from the tippling parents down to the babe at the bottle. Overcrowding in ill-constructed tenement-houses is largely due to "the diversion of income from rent to supply whiskey."[1]

Ignorance, and its attendants, heedlessness and criminal neglect, play an important part in the causation of fatal diarrhœa in infancy, inasmuch as they tend to bring into operation the agencies which occasion the disease. The lack of moral sense which often accompanies ignorance is the cause of much stupid, wilful, and even criminal neglect of the most obvious duties involved in the care of infants. When the parents ignore the simplest and most natural laws of hygiene and infant diet; when they view with heedless indifference the most alarming symptoms, and delay to seek medical assistance, then the infant's chances of life are small.

Ignorance, as statistically expressed in the form of *illiteracy*, is a condition which in many sections of this country prevails in its most marked degrees almost exclusively among our foreign inhabitants. We therefore find that ignorance and foreign nationality go hand in hand as causes of infantile diarrhœal disease. In proof of the connection existing between these factors, we append the following table,[2] which exhibits facts derived from the national census of 1870, and relating to nine States. These are arranged in the order of their increasing mortality by diarrhœal diseases, while collateral columns show the proportions of foreign inhabitants and of illiteracy existing in the population of each State:

STATES.	Cholera Infantum.		Diarrhœal Diseases.		Nationality.		Illiteracy.
	Death-rate per 1,000 living.	Percentage to deaths by all causes.	Death-rate per 1,000 living.	Percentage to deaths by all causes.	Foreigners per 100.	Irish per 100.	Unable to read, aged 10 years and upward, per 1,000.
Maine	0.29	2.31	0.72	6.79	7.7	2.5	21.5
Vermont	0.32	2.92	0.92	8.47	14.2	4.2	45.9
New Hampshire	0.44	3.23	1.00	7.35	9.3	3.8	23.9
Connecticut	0.71	5.57	1.19	9.39	20.7	13.1	36.6
Pennsylvania	0.76	5.09	1.51	10.09	12.6	6.7	37.4
New York	0.82	5.17	1.88	11.88	25.7	12.0	37.3
New Jersey	0.86	7.39	1.47	12.60	20.8	9.5	40.8
Rhode Island	0.91	7.18	1.44	11.41	25.4	14.5	70.4
Massachusetts	1.16	6.51	1.93	10.81	24.2	14.8	51.4

[1] See an address on the Sanitary Condition of Glasgow, by Dr. J. B. Russell: Medical Times and Gazette, Aug. 19, 1876.

[2] From a report on the Sanitary Condition of Boston, 1875, p. 151.

We see by these figures that of the nine States compared, Massachusetts, with the highest death-rates by cholera infantum and by diarrhœal diseases, has also the largest proportion of Irish population, and, except Rhode Island, the largest proportion of illiterate inhabitants. Maine, on the other hand, heads the list in all these particulars. It is impossible to escape the inference that these forms of mortality are largely associated with the prevalence of educational shortcomings for which our people cannot be held responsible. So long as a large proportion of our inhabitants consists of ignorant foreigners, so long will the consequences of such ignorance as characterizes them be apparent in our yearly records of mortality.

Prevention.—We have seen that of all the deaths that occur in early childhood, by far the greater part are due to infantile diarrhœa, and we have also seen that this form of disease is dependent for its production upon a conjunction of causes, of which several are manifestly of a removable character. The prevention of undue infant mortality must therefore consist largely in the prevention of the diarrhœal diseases of infancy, and the means by which this result can be accomplished must consist in the removal or diminution of such causes of infantile diarrhœa as can be brought under sanitary control.

The causes concerned are comprised in the following combination of conditions: improper food administered to city-bred infants in overcrowded and uncleanly localities during the prevalence of extreme summer-heat. Taking up successively each of the foregoing causal conditions, we shall find them to be controllable in various degrees by means of sanitary agencies.

The *excessive heat*, which plays so important a part, must, of course, be regarded as an unremovable and almost unavoidable cause of infantile diarrhœa. In a small proportion of cases it may be possible for infants, when attacked, to be withdrawn from exposure to the higher degrees and worst forms of summer-heat, by removal from their city homes to neighboring localities, where fresher and purer air may be obtainable. A timely move to the sea-shore, or to some breezy rural suburb, sometimes suffices, as is well known in our great cities, to restore a dangerously sick child to health. Even without recourse being had to this means, which must often be beyond reach, some relief from the pernicious influence of excessive heat may be found in a variety of measures pertaining to private hygiene, by which the temperature of the infant and of the dwelling may, to a certain extent, be reduced. These means are of a simple nature, and the only obstacles which stand in the way of their adoption proceed from the ignorance and carelessness of the parents or guardians of the sick ones.

Overcrowding of the poor inhabitants of cities, the evil effects of which are felt more severely in infancy than at any other age, can be kept in check, to a certain extent, by municipal enactments relating to the survey and inspection of buildings and to the public health. Building laws should be so framed as to regulate the laying out of streets, courts, and alleys with a sufficient provision of air-spaces, play-grounds, and

parks. Boards of health should have powers to remove the inmates of improperly constructed, ill-drained, or overcrowded tenement-houses. In addition to the enforcement of existing sanitary laws by public authority, much good can be accomplished in this direction by philanthropic associations having for their object to improve the homes of the poor.

Filth is, as we have seen, the agency to which severe diarrhœal disease is chiefly due. Whether the inhaled air or the swallowed food be considered as the chief or only vehicle of the filth-infection which occasions fatal infantile diarrhœa, in either case, the fault lies in impurity of the air resulting from filthy surroundings. The means by which the filthiness of great cities may be kept in check are well known, and need not be rehearsed here. They relate chiefly to the removal of sewage and of refuse-waters and matters of all kinds from streets and houses and from the underlying soil.

Unsuitable food is the agency through the intermediate instrumentality of which heat and filthiness exert their noxious influence upon young children. We have seen that breast-nursed infants are very much less liable to contract the most severe forms of diarrhœal disease than those which are hand-nursed, if, indeed, they do not, as Meissner asserts, enjoy complete immunity. Are we, then, to infer that the only safety for young infants lies in breast-nursing? Such a conclusion, if applied to all conditions of infant life, would not appear to be justified by the facts of common experience.

Artificial feeding, *properly carried out*, undoubtedly gives quite satisfactory results in a large proportion of cases. In the country, where the conditions are very much more favorable than in the city, infants of all classes are successfully brought up by hand, and the rates of mortality are rarely inordinately high. In cities, among the well-to-do and enlightened, similar results are frequently observed. Even in such cases, however, it may be questioned whether the fact of survival is demonstrative of the complete success of hand-feeding. There is good reason to believe that an agency which so often proves fatal must almost always occasion some impairment of health in those who do not succumb. Be this as it may, however, the fact remains that it is perfectly possible to bring up infants by hand without breast-milk, provided that the necessary conditions are fulfilled. These are sufficiently well known, and have been fully set forth elsewhere.

In cities, however, among the poor, in the classes and districts where infant mortality exists on a large scale as a yearly phenomenon, matters are very different. The exigencies of successful hand-feeding are such that failure is almost inevitable when poverty, ignorance, carelessness, and, perhaps, criminal neglect are brought into conjunction with the additional and probably insurmountable difficulties of filthy surroundings, due to overcrowding and to defective ventilation, drainage, and sewerage. Under such conditions bottle-fed infants rarely survive the summer months.

The chief means of prevention, then, must consist in measures designed to encourage and facilitate maternal lactation, or wet-nursing,

among the poor in cities. Inasmuch, however, as cases are constantly occurring in which breast-nursing is impossible, and in which recourse must, of necessity, be had to hand-nursing, parents and guardians should be made to learn the most approved methods of artificial feeding, and be put in a position to carry them out. By what agencies, if any, these requirements may be fulfilled, we will presently try to show.

Poverty and *ignorance* are the last of the causes with which we have to deal. However discouraging the fact may be to the sanitarian, these defects constitute the underlying conditions of the anti-hygienic agencies to which the prevalence of fatal infantile diarrhœa is due. To rear an infant, whether at the breast or by hand, a certain amount of intelligent care, and of self denial on the part of the parents, is needful. The easiest, and by far the safest, plan is for the mother to nurse her child. To do this, however, she must be able to forego labor in order to devote herself to its wants. The father, then, must contrive, by dint of industry, frugality, and thrift, to support the family. But when the father is disabled or out of work, idle, thriftless, or intemperate, or when, as in the case of illegitimate children, there is no father who can be relied upon, then the means of existence fail and the infant is the first to suffer.

Too often, then, the mother, even if she have breast-milk enough, gives up nursing her child, thinking erroneously that it will be easier and cheaper to rear it by hand. She is, however, too poor to obtain a suitable supply of pure, fresh milk, too ignorant to know what food the infant needs, and how to prepare and administer it. The infant gradually pines away; if it survive until the midsummer it then speedily receives the *coup de grâce.*

The means by which parents may be taught, helped, or, if necessary, coerced, to do their duty by their offspring cannot be said to come within the province of legislation, even in communities where the public authorities have the greatest power to scrutinize and regulate the private life of citizens within their homes. But if infants, when under the care of their parents, are beyond the reach of legislative interference, it is otherwise with those who are being nursed for hire away from home.

The *business of nursing* is liable to a variety of abuses, which are extremely fatal to infant life. Nowhere have these abuses been so extensively prevalent, so startling in their results, and so carefully investigated, as in France.[1] In that country it is very common for mothers of the better classes, especially in cities, to renounce nursing their children, the custom being either to entrust the infants to hired wet-nurses, or else to send them away from home to the country to be reared by hand. In the former case the nursling is generally properly cared for; but the child of the wet nurse, being confided to some stranger to be reared by hand

[1] See C. Devilliers: Nouveau Dictionnaire de Médecine et de Chirurgie Pratiques, Vol. XXIV. Article Nourrices.

Brochard: De la mortalité des nourrissons en France, etc., Paris, 1866.

Monot: De la mortalité excessive des enfants, Paris, 1872.

at the least possible expense, has but slender chances of life. Among city-born infants who are sent away to the country to be dry-nursed, terrible rates of mortality are known to prevail. Many attempts have been made by the various governments to repress the abuses to which the business of nursing and of baby-farming was liable, the latest enactment being the so-called *loi Roussel* for the protection of infants, adopted by the National Assembly in 1874.

The disclosures relating to baby-farming and its abuses which came out some years ago in England, led to the passage of an *Act for the Protection of Infant Life*, which came into operation in 1872. The chief object of this act was to provide for the registration and supervision of nurses who receive infants in their homes. A similar act was passed in 1876 by the legislature of Massachusetts.[1]

If legislation is powerless, as we have seen, to exert any direct action for the protection of infants against the ignorance, carelessness, and poverty of their parents, a large field remains for the intervention of private charity and of philanthropic associations.

As an example of what can be done by *private charity*, we will cite the results obtained in Mulhouse by Mr. Dollfus. He owned a large cotton mill, in which many female operatives were employed. Among these births were frequent, and the infants used to die in great numbers for lack of nursing and proper care. In order to check the undue mortality so caused, the proprietor of the mill caused a fund to be established, to which all the married women subscribed, and to which he himself contributed. Each woman who subscribed was entitled to support from the fund during a period of two months after her confinement. Later, when she had resumed work at the mill, she was allowed leave of absence in the middle of the day, in order to go home and attend to her child. By this means the mortality was reduced to less than half the rate that had formerly prevailed.

Philanthropic associations for the protection of infant life have been

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[1] AN ACT FOR THE BETTER PROTECTION OF INFANTS.

Be it enacted, etc., as follows:

SECTION 1. Whoever engages in the business of taking nursing infants or infants under three years of age to board, or of entertaining or boarding more than two such infants in the same house at the same time, shall within two days after the reception of each such infant beyond the first two, give written notice to the board of health of the city or town where such infant is so to be entertained or boarded, specifying the name and age of the child, and the name and place of residence of the party so undertaking its care; and such board of health shall have the right to enter and inspect said house and premises while said business is being carried on, and to direct and enforce such sanitary measures, respecting such children and premises as it may deem proper.

SEC. 2. Any person violating any of the provisions of this act, or refusing admission to such board of health, for the purpose mentioned in the preceding section, shall, on conviction thereof, be punished by a fine of not less than fifty, nor more than five hundred dollars.

[*Approved April* 21, 1876.]

established in many places. The first was organized in Paris, in 1865, with the object of diminishing the enormous mortality growing out of the common custom of putting city-born infants to nurse in the country. The example set by Paris was followed in Lyons in 1866, in Havre in 1869, in Tours and in Pontoise in 1870, in Marseilles and in Rouen in 1873. In England an Infant Life Protection Society was established in 1870, having for its object to procure legislation for the registration and supervision of nurses who receive children in their homes, and it was largely to the exertions of this society that the passage of the Act for the Protection of Infant Life, alluded to above, was due.

The chief object of the enactments and associations for the protection of infant life, to which allusion has just been made, has been to prevent the grave abuses resulting from the employment of wet-nurses and from the business of baby-farming. Much good can also be accomplished in the homes of the poor, in cities, by *charitable organizations* having specially in view the prevention of infant mortality. The principal aim of such societies should be to encourage and facilitate maternal lactation in all classes of society, and to disseminate among the ignorant a knowledge of the rules which should govern the bringing-up of infants. It should also enter into their programme to assist destitute mothers whose means do not allow them to give proper care to their children, and who might be enabled by a little timely assistance either to nurse their offspring, or to procure a sufficient provision of pure fresh milk, the latter being perhaps supplied by the society or obtained through the intermediary of "Diet Kitchens."

Among other means of sanitation which would come within the province of charitable associations for the protection of infant life may be mentioned the establishment of *diet kitchens*, of *infant day asylums* or *nurseries*, and of *seaside or country homes*. Such institutions render invaluable services by enabling very poor and ignorant parents to obtain, at low cost or gratuitously, proper articles of food, and a suitable supply of cow's milk, pure and unadulterated; by providing temporary homes for infants who would otherwise be neglected during the working hours of their mothers; and by affording, at the time of greatest danger, a refuge from the poisonous atmosphere of the city home.

Conclusion.

From all that precedes, the reader will have recognized that infant mortality in its most striking forms, as it exists among the poor inhabitants of large cities, is very largely due to the prevalence of gross infractions against the simplest and most generally recognized laws of infantile hygiene. Such being its origin, and the causes concerned in its production being, for the most part, theoretically removable, it seems as if it ought to be possible to effect a great reduction in the rates of mortality among infants in cities.

We are, however, constrained to admit that the chief agencies at

work to bring about the excessive mortality of infants are the ignorance and poverty which prevail so extensively among certain classes of all urban populations. These agencies, although not amenable to sanitary measures, properly so called, are not altogether unremovable. Improvement may certainly be looked for from educational influences tending to better the mental and moral condition of the ignorant poor classes, and inculcating in parents a proper sense of their duties toward their offspring. But the changes to be thus effected can only take place slowly and gradually, and immediate results must not be expected.

The conclusions to which we are led, with regard to the prevention of undue infant mortality in cities, are that, after the beneficial results to be expected from strict attention to all the details of sanitary administration upon which the healthiness of a city depends, reliance must be placed chiefly upon the philanthropic exertions of charitable associations, organized for the express purpose of assisting parents to understand and carry out the approved rules of infantile hygiene.

VITAL STATISTICS.

"Nature," says Professor Jevons,[1] "though it probably never fails to obey the same fixed laws, yet presents to us an apparently unlimited series of varied combinations of events. It is the work of science to observe and record the kinds and comparative numbers of such combinations of phenomena, occurring spontaneously or produced by our interference. Patient and skilful examination of the records may then disclose the laws imposed on matter at its creation, and enable us, more or less successfully, to predict, or even to regulate, the future occurrence of any particular combination." Such is the method of inquiry to be pursued in investigating the laws of health and disease. The phenomena thus to be observed and recorded are the chief events of human life—births, marriages, deaths—and the various diseases, together with all the circumstances which affect human vitality. Records of such phenomena constitute vital statistics.

A full and accurate knowledge of the people is, in every community, an indispensable requisite for the successful administration of public affairs. Such knowledge is obtained by the public authorities from two distinct sources. In the first place, the enumeration of the people, by which the population, the numbers, the ages, the abodes, the professions, etc., of the individuals composing it are ascertained, is effected by the taking of a census. In the second place, the "movement of the population," under which term are comprehended the births, deaths, and marriages occurring yearly, is determined by means of registration. From these two sources—namely, from the census and from registration—are derived the statistical data, which, when collected, classified, and discussed, yield the statistical results. It is chiefly in the form of results that vital statistics interest the hygienist. Before entering, however, on this, the more important branch of our subject, we must first consider briefly, with reference to their nature and origin, the data which enter into the composition of vital statistics. The enumeration of the population will first engage our attention.

The Census.

The number of individuals composing the population of a country is ascertained by means of an enumeration called a census, which is effected periodically by the government. The information so acquired is of the highest value in many ways, and is the basis of all statistical inquiries. The taking of a census is, however, an undertaking of considerable mag-

[1] The Principles of Science, W. S. Jevons, 2d edit., London, 1877, p. 173.

nitude, involving much labor and expense.[1] It is, therefore, accomplished at intervals of several years. In England and in the United States the census is taken once in every ten years; and this degree of frequency was recommended, as a minimum, by the International Statistical Congress, held at St. Petersburg in 1872.

It is highly important, for the sake of accurate returns, that the enumeration of all the people, constituting a census, should be effected rapidly and simultaneously. In the last census of England and Wales the operation was actually accomplished within twenty-four hours, on the 3d of April, 1871. For this purpose the entire country was carefully subdivided into districts, each of which was made small enough to be canvassed in one day by one of the enumerators, of which there were in all 32,543. The operation was hastened by the use of "prior schedules" left at the residence in advance of the enumerator, to be filled up by the head of the family.

In the United States the period allowed for the completion of the last census (1870) was over three months. A *de facto* enumeration was therefore impossible; and many inaccuracies were rendered inevitable. Prior schedules were not used, though adopted in nearly all other countries. "The experience of the recent enumeration," says the superintendent of the census in his report, "has given fresh illustration of the importance of using this agency in the interest of economy, not to speak of the advantage of securing by means of it a more accurate statement in respect to every matter into which the census inquires." The superintendent of the census lays much stress upon "the essential viciousness of a protracted enumeration," and says that "it is not worthy of a great nation that its census should be so tardily and so loosely taken, as is inevitable in the United States under existing provisions of law."

The taking of a census does not consist only in a simple enumeration of the population. The usual subjects of inquiry are exceedingly numerous, relating to very many circumstances, a knowledge of which seems likely to throw light on the condition of the people considered from many different points of view. None of those topics are matters of absolute indifference to the hygienist, who can indeed truly say: *Humani nihil a me alienum puto.* There are certain subjects, however, in relation to which information is absolutely indispensable for the construction of vital statistics. Chief among them are the following items: (*a.*) The numbers of living individuals of both sexes, and of each sex. (*b.*) The ages of the individuals. (*c.*) The residence. (*d.*) The birthplace. A few remarks on some of these points may be of service.

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[1] The last census of England and Wales was taken in 1871. The population was enumerated in one day (April 3d) by 32,543 enumerators, employed under 2,195 registrars and 626 superintendent registrars. The entire undertaking was under the direction of the registrar-general, assisted by Dr. Farr and Mr. J. F. Hammick. The householders' schedules numbered in all 6,500,000, and weighed about 41 tons. The enumeration books and forms sent out weighed about 54 tons.

The expenses of the last United States census (1870) amounted to $3,360,884.

With regard to the *ages*, various subdivisions are in use, longer or shorter intervals of time being adopted. There can be no doubt that the shorter the space of time allotted to each group the better. Therefore the division by single years is to be preferred. For infants, however, this measure of lifetime is too large, and the ages should, if possible, be stated in months up to the age of one.[1] Inaccuracies of statement with regard to the ages of adults, at and after middle life, are everywhere exceedingly common, as is made evident by the concentration upon round numbers and quinquennial periods, the causes being carelessness, ignorance, or a reluctance to confess the true age.

The *birthplace* is, in the United States, a very important item of information, on account of the great diversity of nationalities entering into the composition of our population. Data collected under this head, when utilized in connection with the registration returns, yield very interesting statistical results, as will be shown later.

The chief requisites of a census[2] are, in brief, as follows: The census should be *nominal*, and should enumerate the *de facto* population.[3] The census should be decennial, being taken preferably in years whose number ends in zero (1860, 1870, 1880). The enumeration should be accomplished in a single day, or should, at least, be referred to a specified day and hour. The subjects of inquiry should comprise, as a minimum, the following items: *a*, names; *b*, sex; *c*, age (by years; infants under one by months); *d*, relation to head of household (wife, son, nephew, etc.; servant, apprentice, lodger, etc.); *e*, married or single; *f*, calling; *g*, religion; *h*, language; *i*, illiteracy; *j*, birth-place and nationality; *k*, residence; *l*, infirmities (blindness, deaf-mutism, idiocy, insanity, cretinism).

Registration.

The *movement of the population*, by which is meant the yearly births, deaths, and marriages, is ascertained by means of registration. Records of these events, as accurate and complete in all particulars as possible, are collected, arranged, classified, and finally published, in the form of registration reports. While the census takes, as it were, an inventory of the population at stated intervals, registration keeps an account of the yearly gains and losses due to births, deaths, and migration, by which the population increases or decreases in the intervals of the census.

Registration fulfils many useful purposes. It serves, in the first place, to facilitate the identification of individuals for the transmission of property, and for the protection of life against crime. It affords data for the determination of life contingencies, which form the basis of life insurance.

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[1] See the Census of the State of Massachusetts of 1875.

[2] Summarized from conclusions adopted by the Statistical Congress of St. Petersburg in 1872. See M. Block: Traité de statistique, Paris, 1878, p. 344.

[3] In a *de facto* population all the individuals present in a locality at the time of the count are attributed to that locality, whether they be residents or not. In a *de jure* population, individuals are attributed to the locality in which they have their residence.

Lastly, it furnishes to medical and sanitary science information of the highest value concerning the state of the public health. It is from this point of view that registration interests the hygienist. By means of registration, efficiently conducted, the sanitary authorities of any locality are promptly informed of the prevalence of preventable diseases, and are thus enabled to take the necessary measures for the protection of the public health with the least possible delay. Moreover, registration reports, taken in connection with the census, yield statistical results which throw light upon the causal conditions under which prevailing diseases occur, and thereby become the source of invaluable contributions to the science of preventive medicine.

In no country has registration been so fully developed and so carefully organized as in England. There is a registrar-general for England and Wales, who has his offices in London, at Somerset House; there is one for Scotland, in Edinburgh; and one for Ireland, in Dublin. These three offices have the entire charge of the vital statistics of the United Kingdom, not only the management of registration, but also the taking of the decennial census being entrusted to them.

The office of registrar-general of England was created in 1836. The first act of Parliament for the registration of births, deaths, and marriages was passed in 1837, and civil registration began on July 1st of that year. The first of the series of yearly reports of the registrar-general was published in 1839, having been prepared by Dr. William Farr, who has continued from that time until now to direct the statistical department of the registrar-general's office. The registration law was improved from time to time by successive amendments, and in 1874 a new law was enacted, whereby the registration of births and deaths was rendered compulsory, penalties for non-compliance being prescribed.

In the previous thirty-nine and a half years, when registration was not compulsory, the registration of births had been defective, the proportion of unregistered births being estimated at about 5 per cent.[1] Few deaths, on the other hand, were believed to escape registration, but in a considerable proportion of cases the medical certificate of the cause of death was unsatisfactory or altogether wanting. The efficacy of the new law was apparent in the returns for 1876. The birth-rate for that year was the highest ever recorded, being 36.6 per 1,000, or 1.2 per 1,000 higher than the average for the ten years preceding. The number of "uncertified deaths" had greatly diminished under the new statute.

There are in England and Wales nearly three thousand registrars and superintendent registrars, whose duty it is to collect and forward to the registrar-general at Somerset House all the certificates returned to them throughout the country.[2] All the vast amount of raw material so central-

[1] Thirty-ninth Report of the Registrar-General.

[2] The number of events registered in 1876 was 1,802,031. As many names of persons, whose births, deaths, and marriages were registered, were added to the printed alphabetical indexes preserved at the registrar's office, bringing up the total number of names indexed in thirty-nine and a half years to 55,880,349. See Thirty-ninth Report.

ized is sorted, classified, and variously elaborated in the statistical department of the office. The results of this great labor are made public in the form of weekly, quarterly, yearly, and decennial reports. Every Tuesday a printed pamphlet is prepared and sent over the kingdom, giving the deaths and their causes, together with the conclusions and warnings to be drawn from them, for the week ending on the previous Saturday, and collected from twenty-three towns, containing over eight millions of inhabitants. The yearly reports of the registrar-general, and, above all, the admirable decennial supplements drawn up by Dr. Farr, in which are set forth, condensed, and discussed the vital statistics of the whole country, covering a period of ten years, are wonderful monuments of science, skill, and labor. It is no exaggeration to say that these important publications—in which so much widely diffused learning and so much industry are embodied under the leadership of one master-mind—deserve to be ranked among the most striking and characteristic products of the age in which we live. As another phase of civilization found its expression in the Elgin Marbles, and another yet in the great church of Saint Peter's at Rome, so do these unprecedented collections of vital statistics present a typical illustration of the enlightened state of civilization which has been attained in England.

In the United States registration has been, and is still, very imperfectly organized and carried out. By the Federal Government, in the first place, very little attention is paid to vital statistics. The census, being a political necessity, for the apportionment of representation, is provided for by the Constitution, and is taken every ten years, on a uniform plan, throughout the country. In addition to the enumeration of the population, attempts are made to collect other statistical data. The results, however, have been exceedingly unsatisfactory. Thus, with regard to the statistics of mortality, it is stated in the report of the last census (1870) that "at no one of the three censuses taken under the Act of May 23, 1850, has the aggregate number of deaths returned by the assistant marshals risen above two-thirds of the deaths probably occurring during the year of enumeration." It is therefore impossible to construct a correct life-table for the population of the United States, or even to determine the death-rate of the country.[1]

[1] In the Fifth Report of the Registrar-General, in 1843, it was stated (page 19) that no correct life-table could be formed for the population of America until they adopt, in addition to the census, the system of registration which exists in European States.

In the Report of the Ninth United States Census (Vital Statistics, page xv), the following remarks are made: "The great deficiency manifest in the returns of deaths, a deficiency inherent in any system which seeks to secure complete returns of these events for an entire year by simply conducting an inquiry at its close, will, for the future, it is earnestly hoped, be remedied by legislation, establishing a national system for the registry of deaths and of births as they occur. By no simpler or less radical process is it possible for the statistics of the movement of population of the United States to be placed on a par, as to efficiency and completeness, with that of England, France, Belgium, Prussia, Sweden, Norway, and certain other of the progressive

In the several States of the Union the amount of attention devoted to registration has varied ; but, for the most part, it has been very inadequate. In 1876, according to Dr. Bowditch's investigations, only nine States could be said to have any registration at all (Connecticut, Georgia, Massachusetts, Michigan, New York, Ohio, Rhode Island, Vermont, Wisconsin), and in only two (Massachusetts and Rhode Island) was registration asserted to have been carried out with any approach to accuracy. Even in these two States it had been, according to Dr. Bowditch, of doubtful value, and he expressed his belief that no State in the Union, nor the United States as a nation, had at that time (1876) any proper system for the registration of vital statistics.[1]

In many cities of the United States registration has been long established, and in a few of them the results obtained have been of considerable value. The registration reports of New York city, Philadelphia, Washington, Boston, and Providence are among the best documents of the kind published in this country. All, however, judged from the high standard of English registration, are more or less defective in many important particulars.

It is evident from what precedes that registration is very unequally and inadequately provided for in the United States, being wholly neglected in most of the States and imperfectly organized and executed in the others. No uniform comprehensive scheme of national registration exists, such as has been adopted in England and in most of the other countries of Europe.

We will now consider, as briefly as possible, the chief requisites of a proper system of registration of vital statistics, laying stress principally upon those details which most particularly interest the hygienist. By far the most important branch of registration, from the standpoint of preventive medicine, being that which relates to deaths and their causes, we shall dwell at greater length on this subject. On the registration of births we shall have but little to say, and on that of marriages still less.

Registration, to be of value, must be conducted according to certain general principles which apply to all statistics. The data collected must be uniform and accurate as regards quality, and they must be complete as regards quantity.

Uniformity of data is indispensable. Without it the comparison of the statistical results, among themselves and with other collections of similar facts, which is one of the most instructive uses of vital statistics, be-

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States of Europe. Legislation by the several States of the Union is necessarily inadequate to the accomplishment of this object.

Elsewhere, in the same report (page 9), regret is expressed "that the census should not afford the data for determining with absolute precision and certainty the death-rate of the country, whether in the aggregate or by classes of the population. This can never be done, it is added, without a national scheme of registration, stringently enforced by penalties."

[1] See Dr. H. I. Bowditch's essay on Public Health in America, Boston, 1877, pp. 66, 112, 116, 120, 172. See also Eighth Report of the State Board of Health of Massachusetts : Essay on Registration, by Dr. C. F. Folsom, Secretary of the Board.

comes difficult or impossible, and is liable to be the souree of erroneous conelusions. Henee the need of a uniform plan of registration, to be applied throughout the eountry whose "movement of population" it is proposed to observe. England, Franee, Germany, and many other countries have such national systems of registration. The United States, as we have seen, has none.

Accuracy of data is obviously one of the most important requisites of sueeessful registration. The value of any statistics, and the trustworthiness of the eonclusions drawn from them, must depend upon the value of the individual faets whieh enter into their eomposition. To ensure the utmost aceuraey it is necessary to guard against ignoranee and earelessness by a eareful seleetion of the persons to be entrusted with the preparation and colleetion of the returns. We shall have oeeasion later, when speaking of the medieal certifieate of the "eause of death," to say more upon this subjeet.

Completeness of data is attainable in only one way, namely, by making registration compulsory, with penalties for non-complianee with the law. In no other way is it possible to overeome the diffieulties growing out of the indifferenee, the carelessness, the laziness, the selfishness, or the ignoranee of the individuals eoncerned. The experiment of eompulsory registration has been largely tried in many countries, and the results have been exceedingly satisfactory.

Registration of births.—Complete records of all the births occurring in any eommunity are very important, not only for the sake of the protection to life resulting therefrom, but on aeeount of the value to sanitary seienee of the statistical information so obtained. A law sueh as has been in force in England sinee January 1, 1875, compelling parents, under a penalty, to record births within a limited period of time, affords the only means of obtaining eomplete returns.

The chief data to be determined are as follows: (*a*) the sex; (*b*) the date of birth; (*c*) the plaee of birth; (*d*) the number of births (twins, triplets); (*e*) legitimacy; (*f*) the nationality of the parents. It has been proposed also to determine the ages of the parents at the births of their children.[1]

Still-births should not be registered among the births nor among the deaths, but should be recorded by themselves in a separate and distinet category. Careful supervision on the part of the registrar is necessary to make it impossible for live-born ehildren to be buried as still-born.

Registration of deaths.—This braneh of registration has for its objeet the eolleetion and preservation of complete and aeeurate reeords relating to deaths, to the nature of fatal diseases, and to the conditions under which the latter oecur. The knowledge so obtained is of value to preventive medicine in more ways than one. In the first plaee, by pointing out the localities in whieh preventable diseases are actually oeeurring or prevalent, it serves to direet the operations of sanitary authorities. In the

[1] Thirty-seventh Report of the Registrar-General of England, p. 6.

second place, it furnishes collections of facts which, when brought together, compared, and discussed, in the form of vital statistics, throw light upon the causal conditions underlying the origin of diseases, and thus become the source of valuable contributions to the science of preventive medicine.

These purposes can be successfully fulfilled only under certain conditions. To be useful, on the one hand, as guides for sanitary measures, the registration returns must not only be complete and accurate, but they must reach the sanitary authorities whom they are destined to enlighten, with the least possible delay. Prompt information is no less necessary than prompt action in such matters. To serve, on the other hand, as sources of scientific knowledge concerning the causation and the prevention of diseases, it is indispensable that the yearly collections of facts obtained by means of a suitably organized system of registration should be submitted to the consideration of a trained statistician and hygienist, by whom they should be prepared for publication in the form of registration reports. For such a task, it seems needless to say that only members of the medical profession are qualified. It is therefore expedient that the registration of deaths should invariably be brought into close relations with the sanitary department, if not placed under its immediate direction. Moreover, the task of converting the collected facts into vital statistics, and of discussing their significance, should be entrusted only to suitably trained physicians.

The facts relating to decedents which it is most desirable to record by means of registration are as follows: The date of the death, the name of the deceased, the sex, the color, the condition (single, married, or widowed), the age, the residence, the occupation, the place of birth, the places of birth of the parents, the fatal disease or cause of death, the place of burial, and the date of the record.

The *age* should be stated in years, except in the case of infants, whose lives are often so short that this measure of time is much too large. The ages of infants dying during the first week should be given in days; for the first two years of life, the age should be given in months.

The *birthplace* of decedents is an important item of information in the United States, where immigration has brought together so many different nationalities, differing as regards constitutional peculiarities, habits of life, and hygienic conditions. The parentage of decedents is also an interesting subject of inquiry which throws light upon the ulterior effects of national peculiarities transmitted by inheritance or by education to the native offspring of immigrants. Few data have as yet been collected which bear upon this point.

The *cause of death*, by which is meant the disease or injury proving fatal, is to the hygienist, whether sanitary officer or scientist, the most important of all the items of information supplied by registration. This information can obviously have but one source. In every case of fatal sickness, the only person who can reasonably be looked to for a trustworthy statement of the "cause of death" is, of course, the physician in attendance. In many places, therefore, as in England, since 1875, and in

Massachusetts, since 1849, the physician in attendance at the last sickness of any decedent is required by law to contribute to the death-certificate, without which burial is illegal, the statement of the nature of the fatal disease. This measure has for its object to ensure the greatest possible degree of completeness and accuracy in the returns.

The value of the results obtained in this way depends upon several conditions, and is subject to considerable variations. If, in every case of fatal sickness, a properly qualified physician, a *doctor of medicine*, were invariably in attendance, no doubt the proportion of cases in which the cause of death failed to be stated with a reasonable approach to correctness would be small. In fact, however, it often happens that no *physician* is at hand to observe and record the fatal disease. A certain number of persons die without receiving any kind of medical attendance. Moreover, in countries where the practice of medicine is not restricted by law, unqualified persons, such as clairvoyants, botanic physicians, and quacks of every sort, usurp the place of the physician at the bedside of the sick. Such persons, however unfit for the duties assumed by them, are, nevertheless, called upon by the law to certify the cause of death. Herein lies the chief cause of the failure of registration in the United States. Several States, many cities have excellent registration laws. But partly because these laws are not enforced, and chiefly because the practice of medicine is left open to all persons without discrimination, the returns relating to the causes of death have little value.

To ensure a complete and tolerably trustworthy registration of the causes of death in any community, then, two conditions are indispensable. In the first place, the physician in attendance at the last sickness of every decedent must be compelled, under penalties, to supply, to the best of his knowledge, a statement of the fatal disease. In the second place, the practice of medicine must be restricted by law to persons who have received a suitable medical education. In the absence of these conditions, the results of registration can but be incomplete and inaccurate.[1]

The only remedy for the defects of registration due to the unpreventable intrusion of unqualified persons as signers of death-certificates is to be found in the intervention of a careful and experienced registrar. All statements coming from doubtful sources being eliminated by him, returns which, in the aggregate, would have little value, can be so purified as to be of use as indications of sanitary condition.

Even under the most favorable circumstances, there must be unavoidably a considerable degree of inaccuracy in all returns relating to the cause of death, owing, on the one hand, to the ignorance and carelessness, existing to a greater or less extent everywhere among members of the medical profession, and owing, on the other hand, to the existing imperfections of medical knowledge when taken at its best.

Against the shortcomings of practitioners in the matter of death-cer-

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[1] See Dr. C. F. Folsom's paper on Registration: Eighth Report of the Massachusetts State Board of Health, 1877.

tificates, the only remedies are to be found in educational influences, tending to develop in members of the medical profession an interest in registration, and a knowledge of its exigencies, and in the intervention of a skilful hygienist as registrar. The latter should make it his duty to scrutinize the returns, taking every measure to obtain accurate statements of the cause of death, and rejecting all certificates supplied by unqualified persons.

The imperfections of the art and of the science of medicine, which stand in the way of accurate registration, are less easily remedied. Obscure cases must occasionally occur in which it is impossible for the practitioner, however careful and skilful he may be, to arrive at any definite diagnosis. Then there are affections whose nature and whose nosological relations are as yet undetermined, so that similar cases are liable to be registered under different names by equally well-informed physicians.[1]

The *nomenclature of diseases*, to be used by physicians in filling death-certificates is a matter of considerable importance. The requisites of a useful nomenclature are twofold. In the first place, it should be so contrived as not to do violence to generally accepted nosological views. In the second place, it should be adopted and used uniformly on a large scale. The more unanimously any given nomenclature is used, the more homogeneous will be the resulting statistical data, and the more suitable for purposes of comparison. The more widely such a system prevails, the more extensive will be the field of statistical investigation. These advantages are united, unquestionably, in the highest degree in the nomenclature and classification of diseases now used in the registration of England. This system, originally drawn up with great labor and care by a joint committee of the Royal College of Physicians of London, and adopted by the registrar-general of England, was used in the mortality statistics of the ninth census of the United States, and is employed in the registration reports of many States and cities in this country.[2] It has become, for the time being, the common nomenclature and classification for all

[1] Such, for instance, is the case with membranous laryngitis, which is registered by one practitioner under the name of croup, by another under that of diphtheria. Forms of Bright's disease exist in which death is liable to be attributed to heart-disease or to cerebral hæmorrhage. It has lately been asserted that "at least 70 per cent., of the patients who owe their deaths more or less directly to Bright's disease, die with the chief cause of their deaths unrecognized." (Dr. Mahomed on Chronic Bright's Disease: The Lancet, Feb. 22, 1879, p. 262.) Fatal cases of cerebral syphilis and of alcoholism are also liable to escape recognition, and to be registered under misleading designations, so that the frequency of these disorders as causes of death is very much understated in registration reports.

[2] See the Nomenclature of Diseases drawn up by a Joint Committee appointed by the Royal College of Physicians, London, 1869.

Nomenclature of Diseases, etc., of the United States Marine Hospital Service, Washington, 1874.

Ninth Census of the United States: Vital Statistics, p. v.

Nomenclature of Diseases, etc.: Reprint issued by the American Medical Association, Philadelphia, 1869.

English-speaking peoples. This system is, therefore, the one which should be adopted and adhered to without modification, in preference to any other; not, indeed, as being in itself altogether free from imperfections, but because it has the paramount advantage of being in more general use than any other. If, at some future day, changes in the accepted nomenclature and classification of diseases should appear desirable, it is to be hoped that such changes may be effected with the common and unanimous agreement of all the communities in which registration exists.

Registration of marriages.—This branch of registration is of slight interest to the hygienist. The requisite data are analogous to those which relate to births and deaths, and are collected in a similar manner.

Registration of diseases.—It has often been proposed of late years, in the interest of sanitary government, that the prevailing diseases should be reported and registered, as well as births, deaths, and marriages. Several reasons can be brought forward in favor of such a proceeding. In the first place, if diseases were reported to sanitary authorities upon their first appearance, the advent of epidemics would be recognized more promptly than when the earliest tidings are conveyed by the death-certificates. In the second place, our knowledge of the extent to which particular diseases prevail would be more accurate than can be the case if deaths are the only source of information, since the fatality of each disease varies at different times, and is by no means always proportional to the frequency of its occurrence.

A complete registration of all diseases is, for obvious reasons, out of the question. Such registration of disease as has been carried out in various places has been limited almost exclusively to certain of the zymotics, comprising those diseases which are more or less amenable to sanitary control, and in relation to which prompt information is likely to be useful for the protection of the public. Great difficulties have been encountered in the attempts which have been made to obtain complete and prompt returns, owing chiefly, it must be said, to the reluctance of physicians to join in the undertaking. Whenever the registration of diseases has been simply voluntary and optional, the returns have invariably been very poor and incomplete.[1] Experience has shown that it is useless to expect satisfactory results by any means short of a law compelling certain persons, either heads of families or physicians in attendance, to report specified diseases to the sanitary authorities within a fixed limit of time.

The requirements of a plan for the registration of diseases in England are set forth as follows by Dr. Farr: "What is wanted is a staff officer in every county or great city, with clerks to enable him to analyze and publish the results of weekly returns of sickness, to be procured from every district; distinguishing, as the army returns do, the new cases, the re-

[1] See a Report on the Registration of Prevalent Diseases, by Dr. F. W. Draper: Seventh Report of the Massachusetts Board of Health, 1876, p. 477. See also a paper on Registration, by Dr. C. F. Folsom: Eighth Report of the Massachusetts Board of Health, 1877, p. 269.

coveries, the deaths, reported weekly, and the remaining in the several hospitals, dispensaries, and workhouses: these, compiled on a uniform plan, when consolidated in the metropolis, would be of national concern. It has been suggested that the returns of sickness should, to save time, be sent to London, and there analyzed on a uniform system, as the causes of death are. That, with the present postal arrangements, is quite practicable. The thing to aim at ultimately, is a return of the cases of sickness in the civil population as complete as is now procured from the army in England. It will be an invaluable contribution to therapeutics as well as to hygiene; for it will enable the therapeutist to determine the *duration* and the *fatality* of all forms of disease under the several existing systems of treatment in the various sanitary and social conditions of the people. Illusions will be dispelled; quackery, as completely as astrology, suppressed; a science of therapeutics created; suffering diminished; life shielded from many dangers."

Statistical Results.

We have seen what are the sources of information from which the collections of facts are derived, which constitute vital statistics. These data, supplied by the census and by registration, relate, on the one hand, to population; on the other hand, to certain events of human life, namely: births, deaths, marriages, migrations, and diseases. We will now consider the results obtained from such collections of facts when classified, compared, and discussed, according to the usual methods of statistical science.

Vital statistics comprise a vast amount of facts and of information, expressed in the form of tabulated figures, of ratios, percentages, etc., and relating to a great diversity of subjects. Many of these subjects of inquiry are of slight interest to the hygienist; others, on the contrary, are to him invaluable sources of knowledge. Thus, the information relating to population, supplied by the census, and setting forth the aggregate numbers of populations, their density, their rates of increase, the proportionate numbers of the sexes, the age-distribution, the migrations, etc., though very important when considered in conjunction with certain other data, to be spoken of presently, does not, taken by itself, offer much to interest us from the standpoint of hygiene. Much more important to the sanitary student is that branch of vital statistics which exhibits and studies the *movement of the population*. We shall, therefore, give our attention almost exclusively to the statistics of births and deaths, laying stress chiefly on the subject of mortality.

Births.

The data by which the *fecundity*[2] of a people or community is estimated comprise: (1) the total number of births occurring in a year; (2)

[1] Supplement to the Thirty-fifth Report of the Registrar-General, London, 1875, p. lxxx.

[2] Called in French *la natalité*.

the total population living in the middle of the same year. From these two numbers a ratio is calculated, called the *birth-rate*, which expresses the number of births occurring yearly in every hundred, or in every thousand inhabitants. Inasmuch as populations differ considerably in age-distribution and comprise varying proportions of individuals of the reproductive ages,[1] it has been asserted that a more accurate estimate of fecundity could be obtained by determining the proportion of births to living adults, or to total marriages taking place in the population. Birth-rates per thousand living at all ages are, however, in common use, and are therefore most suitable for purposes of comparison.

Birth-rates vary not only with the fecundity of the people, but also with the completeness of the statistical data from which they are calculated. If the registration returns are incomplete, or if the aggregate population is overstated, the birth-rate is diminished. In England the perfected registration law came into operation in 1875, and the birth-rate of 1876 was the highest ever recorded in that country, being 36.6 per thousand. In many parts of the United States, on the other hand, where the registration of births is very incomplete, and where populations are not unfrequently overestimated in the intervals of the census, the recorded birth-rates are apparently low—lower, indeed, than appears consistent with the existing age-distribution of our population.

The following table[2] shows the mean annual birth-rates of nine European countries, together with the highest and lowest rates recorded in any one year in each country:

States.	Mean annual birth-rates, 1853–1874.	Highest annual rate.	Lowest annual rate.
Austria	39.9	44.2	34.7
Prussia	37.8	40.1	33.8
Spain	37.2	39.3	34.4
Italy	37.1	39.1	34.9
England and Wales	34.9	36.2	33.3
Netherlands	34.5	36.1	31.7
Sweden	31.9	35.0	27.5
Denmark	31.6	33.8	29.5
France	26.1	28.0	22.6

Male births are everywhere more numerous than female. To every hundred girls there are born in England 104.2 boys ; in Scotland, 105.4 ;

[1] Thus, in the United States, in 1870, the number living under five years of age was 14.8 per cent. of the population, while persons aged from twenty to sixty years amounted to 43.9 per cent. In France, on the other hand, the living at the same ages under five, and from twenty to sixty, were 9.29 and 53.7 per cent. respectively.

[2] From a paper on Comparative Progress of Population, F. Martin: Journal of the Statistical Society, London, 1877, Vol. 40, p. 598.

in Ireland, 105.5; in France, 105.1; in Austria, 106.3; in Italy, 106.4; in Spain, 106.5. This predominance of males appears to be greater among the first-born children. Thus, in Austria, it was found that among children of primiparæ there were 110.1 boys to 100 girls, while among children subsequently born the boys numbered 105.3. In Norway it was found that the first six years of married life yielded, on an average, 116.3 boys to every 100 girls; from the seventh to the twelfth year, 107 boys were born to 100 girls, while after the twelfth year the female births predominated.[1]

In still-births the males greatly outnumber the females, no doubt in consequence of the greater difficulty of child-birth due to the superior size of male infants. In France (1865–1875) there were 144 still-born boys to 100 girls; in Italy, 140; in Belgium, 135; in Sweden, 133; in Prussia, 129.

The causes and significance of variations in the birth-rate have been the subject of much controversy. A high birth-rate is very generally regarded as a sign of prosperity. At the same time, however, it has been observed that the highest birth-rates occur in crowded cities, among the poorest and unhealthiest classes, and that they generally coincide with high death-rates. It has been asserted that high birth-rates were the cause of high death-rates, the birth-rate being the "controlling element" of the death-rate.[2] The relation existing between births and deaths will be considered later, in connection with the subject of mortality. We will at present only say that high birth-rates and high death-rates, although frequently coinciding, have been conclusively demonstrated by Mr. Humphreys to be results of distinctly separate causes, having little in common.[3] The high birth-rates prevailing in cities are largely due, according to Mr. Humphreys, to the fact that in urban populations a greater proportion of women of the child-bearing ages are married, and that they marry younger than is the case in the country. Another cause which tends to stimulate the birth-rate in cities is the general prevalence of high rates of infant mortality, the intervals of child-bearing being shortened by the early deaths of the new-born.

The influence of *nationality* upon fecundity is an interesting subject of inquiry in this country, where so many different races contribute to form the population. The birth-rates prevailing in each of the countries from which emigrants come to the United States can generally be ascertained; but it is less easy to determine the fecundity of each race when established in the midst of our population. The difficulty of determining the birth-rates of natives and foreigners, and of each of the foreign nationalities, is due to the lack of data relating to the parentages of the living population. The common division of the population, according to the *place of birth*, is entirely unsuitable for the purposes of such an in-

[1] M. Block: Loc. cit., p. 432.

[2] See Address to Society of Officers of Health, 1874, by Dr. Letheby.

[3] See paper on the Value of Death-rates, N. A. Humphreys: Journal of the Statistical Society, London, 1874, p. 437.

quiry, on account of the anomalous age-distribution of the resulting populations to be compared. The so-called "native population," comprising the offspring born in this country of foreigners, contains a great excess of children, while the "foreign population" is made up almost exclusively of adults, with an excess of individuals of the reproductive ages. It is obvious that the population of foreigners domiciled in this country, if taken as the basis for comparative estimations of fecundity or mortality, must show a disproportionate frequency of all the events which occur exclusively or mainly in the adult time of life, such as births, still-births, marriages, deaths by consumption, etc. From such misleading comparisons of unsuitable data, the erroneous inference has repeatedly been drawn that the foreigners established in this country are three or four times as prolific as the natives.

Certain facts, unquestionably, seem to show that the fecundity of the foreign-born population of the United States is greater than that of the native population;[1] but the difference is very much less marked than has been asserted. It is, moreover, not improbable that the difference is due to social circumstances rather than to any national peculiarities, and that the superior fecundity of the foreign element of our population is similar in extent and in causes to that which characterizes poor urban populations in general. The foreigners in this country are mostly agglomerated in towns and cities under conditions which everywhere produce high birth-rates, while the native element, on the other hand, corresponds in the main rather to the classes which in England furnish comparatively low birth-rates. Notwithstanding the greater fecundity of the foreigners, the mortality of their offspring is so great that it is very questionable whether the rate of increase is as great among them as among the native inhabitants of the country.[2]

Mortality.

Methods of statement.—The mortality, or liability to death, prevailing in any community or group of individuals, is determined and expressed by means of a ratio between the numbers of the living and of the dying in a year. This ratio either states out of how many living one dies yearly, and is obtained by dividing the population by the yearly deaths; or it states

[1] The last census of the State of Massachusetts showed that, of all the native-born women over twenty years of age, over 57 per cent. were mothers, while of the foreign-born women of the same ages nearly 66 per cent. were mothers. The births of 1874 being compared with the number of mothers enumerated in 1875, it was found that while among the native-born mothers there was one birth in every nine mothers, among the foreign-born mothers the proportion was one in every $4\frac{3}{4}$. The average number of births to native-born mothers was 3.52; to foreign-born mothers, 4.91. (Census of Massachusetts for 1875, Boston, 1876, p. 42.)

[2] It has been asserted by a distinguished authority—Dr. Edward Jarvis—on the strength of arguments which cannot be reproduced here, that "the natural increase is at a lower rate in the foreign than in the American families." (See the Atlantic Monthly, April, 1872, p. 468. See, also, the Abstract of the Census of Massachusetts of 1865, p. 296.)

how many die yearly out of one hundred or one thousand living, being then obtained by dividing the total deaths occurring in a year by the population living in the middle of the year, and multiplying the quotient by 100 or by 1,000.

The resulting statement of mortality is a *general* death-rate, expressing the mortality by all causes of the aggregate population, of both sexes, and of all ages. Other *special* death-rates are also used, distinguishing the sexes, the ages, the places of residence, the occupations, etc., of the persons living and dying, and showing how many die by all causes out of 1,000 living males or females; out of 1,000 persons, or males, or females of specified ages; out of 1,000 individuals inhabiting particular localities, or classes of localities; out of 1,000 individuals following particular callings. Still another kind of special death-rate distinguishes the causes of death, showing how many persons die yearly by particular diseases, or classes of diseases, out of every 1,000 living; and such death-rates may also distinguish age and sex. All these statements of mortality have their usefulness, serving to show the variations of mortality, and by inference of healthfulness, under varying conditions of sex, age, locality, occupation; showing, also, the forms of disease prevailing under such varying conditions, and thereby enlightening the hygienist with regard to the causes and prevention of fatal diseases.

The data from which death-rates are calculated are, in the first place, the total deaths occurring in the specified time (one year), as determined by registration; and, in the second place, the population or number of persons living at the middle of the period in which the deaths occur, and for which the rate is required. The methods by which the population living at any given time is estimated from the returns of the most recent census, the known rate of increase, the yearly births and deaths registered, and the records of migration, cannot be described within the limits of this chapter. The reader who is desirous of accurate and complete information regarding these questions of statistical *technique* must be referred to special treatises on the construction of life-tables, in which the methods of computation and the requisite algebraic formulæ, together with the corrections for defective or inaccurate data, are set forth at length.

The value and significance of general death-rates as tests of sanitary condition have been disputed,[1] on the ground that disturbing influences exist which have no connection whatever with the condition of the public health. It has been urged that the mortality of males and females differs somewhat; that the mortality of infancy, of adolescence, of middle life, and of old age, differs enormously; and that, inasmuch as the proportions of males and females (the sex-distribution), and the proportions of young, middle-aged, and aged lives (age-distribution) vary in different populations, therefore the death-rates of populations so differing must be subject to great variations, even if their sanitary conditions are the same.

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[1] See Dr. Letheby's Presidential Address at Opening of Session of 1874 of the Society of Officers of Health, London.

Thus, a high birth-rate, adding constantly to a population large numbers of infants and young children, among whom very high rates of mortality prevail, must necessarily, it has been said, be attended by a high general death-rate. In fact, it has been asserted that the birth-rate was really the "controlling element" of the death-rate; that high death-rates were caused by high birth-rates. The fact that high birth-rates and high death-rates are generally found to coincide in the same populations seemed to bear out this theory.

In answer to these views, however, it has been shown by Mr. N. A. Humphreys[1] that the variations of the death-rate due to differences of sex and age-distribution are in reality inconsiderable. The disturbance occasioned by the largest existing disproportion of the sexes in any English community does not exceed 0.2 per 1,000 in the rate of mortality. The disturbance due to variations of age-distribution is greater, amounting in extreme cases to 2 per 1,000; but, in the case of urban populations, not exceeding 1 per 1,000. This disturbing agency is, however, shown by Mr. Humphreys to have an effect which is just the reverse of that alleged, for a high birth-rate, instead of producing an age-distribution favoring a high death-rate, is, on the contrary, unavoidably attended by such an age-distribution as tends to lower the death-rate. The effect of the excessive number of infants in populations with high birth-rates is more than balanced, says Mr. Humphreys, by that of the excessive number of children and adults between five and sixty years of age, among whom the rate of mortality is low, and by that of the small proportion of persons aged sixty years and upward, among whom the rate is high. The observed frequent coincidence of high birth-rates with high death-rates, upon which the false theory that the birth-rate governed the death-rate has been largely based, is due to the action of distinctly separate causes. High death-rates occur chiefly in cities, for reasons which are tolerably well known. High birth-rates occur also in cities, being due in a great measure to the larger proportion of young married women in urban, as compared with rural populations. Mr. Humphreys' conclusion is that no one of the alleged disturbing influences, or the combined result of them all, would so affect a death-rate calculated on the "national system" as to warrant its being disregarded as a test of sanitary condition.

The most accurate statement of mortality is afforded by a *life-table*, deduced from the ratio between the deaths and the population at different ages. Such a table contains in its various elements a great variety of information concerning the chances of living and dying. It exhibits, in the first place, the deaths and the number surviving (hence called by the French *table de survie*) at each year of age out of a million children born alive. It supplies also a table of mortality, showing the number of annual deaths at each year of age among a given number (a hundred, or a thousand) of the living at the same age. It thus shows the death-rate at

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[1] Paper on the Value of Death-rates as a Test of Sanitary Condition, by N. A. Humphreys, F.S.S.: Journal of the Statistical Society, London, 1874.

each year of age. It shows also the probability or chance of living a year or any number of years at any age. It gives the probable duration of life—*vie probable* of the French—which is the time in which the number born is reduced one-half. It shows also the expectation of life, or after-life time—*vie moyenne* of the French—at birth or at any year of life. An exposition of the methods employed in the construction of life-tables would here be quite out of place. For full information on this complex and difficult subject the reader must be referred to treatises dealing with the technicalities of statistical science.[1]

A life-table being considered to afford the most satisfactory measure of the relative duration of life, either of classes or of different communities, the next best test is the mortality obtained by dividing the deaths by the living at each age. After this comes the general death-rate, or ratio of the total deaths to the total population. Such is the order, as regards scientific value, in which the different methods of appreciating mortality are placed by sanitary statisticians.

General death-rates.—The following table[2] exhibits the mean annual death-rates that prevailed during a period of twenty-two years (1853–1874) in nine European countries, together with the highest and lowest yearly rates recorded in each country:

States.	Mean annual death-rate.	Lowest annual rate.	Highest annual rate.
Denmark	20.2	18.3	24.3
Sweden	20.3	16.3	27.6
England and Wales	22.2	20.5	23.7
France	24.2	21.4	34.8
Netherlands	25.5	22.6	31.2
Prussia	27.1	23.7	34.0
Spain	29.7	26.3	32.8
Italy	30.2	27.7	34.2
Austria	32.2	28.1	46.0

Such being the mean death-rates of these countries, we will now add a table giving in juxtaposition their mean birth-rates and death-rates, together with the mean yearly surplus of births over deaths in each country.

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[1] See The Construction of Life-Tables by Dr. Wm. Farr, Fifth Report of the Registrar-General of England, London, 1843, p. 342. See also English Life-Table, with an Introduction by Dr. Wm. Farr, London, 1864. Encyclopædia Britannica : Article, Mortality, by Mr. Milne. Essay on Vital Statistics, by E. B. Elliott. Proceedings of the American Association for the Advancement of Science, 1856.

[2] This, and the table following it, are from the paper on Comparative Progress of Population, by F. Martin : Journal of the Statistical Society, London, 1877, Vol. XL., p. 602.

States.	Mean annual birth-rate.	Mean annual death-rate.	Surplus of birth-rate over death-rate.
England and Wales........	34.9	22.2	12.7
Sweden..................	31.9	20.3	11.6
Denmark.................	31.6	20.2	11.4
Prussia....................	37.8	27.1	10.7
Netherlands..............	34.5	25.5	9.0
Austria...................	39.9	32.2	7.7
Spain.....................	37.2	29.7	7.5
Italy.....................	37.1	30.2	6.9
France....................	26.1	24.2	1.9

"It will be needless," says the author from whom these figures are borrowed, "to dwell on the extreme significancy of the preceding table, the figures of which have an eloquence of their own. They proclaim very distinctly that there are five States, mainly with inhabitants of Teutonic blood, England, Sweden, Denmark, Prussia, and the Netherlands, the population of which is more or less rapidly increasing; that there are three other States of either mixed or Latin race, the population of which grows at a moderate rate; and, finally, that in one State, France, the progress of population is almost stagnant, the percentage of births differing not greatly from that of deaths."

Influence of sex and age.—Sex and age are together distinguished in

Ages.	Sex.	France.	Russia.	Austria.	Italy.	Bavaria.	Prussia.	Netherlands.	Belgium.	England.	Sweden.	Norway.
0-1	Males.....	236.0	328.0	331.0	270.0	408.5	236.0	228.0	205.2	210.0	165.0	158.0
	Females...	197.0	294.5	275.0	238.0	366.4	205.0	194.5	168.0	171.0	140.0	131.5
	Persons...	217.0	316.6	303.0	254.0	372.2	220.3	211.2	186.4	190.7	153.0	144.3
1-5	Males.....	34.8	54.8	41.3	54.0	42.1	47.0	36.3	35.6	37.1	32.5	29.4
	Females...	34.5	52 5	39.8	53.8	37.6	45.1	36.5	36.0	36.2	29.8	28.7
	Persons...	34.6	54.6	40.5	53.9	39.8	46.0	36.4	36.1	36.7	31.1	29.1
5-15	Males.....	6.8	9.8	7.3	....	8.1	7.0	7.4	7.0	6.4	7.1	6.8
	Females...	7.6	9.4	7.3	....	6 7	7.3	8.5	8.5	6.9	6.7	7.2
	Persons...	7.2	9.6	7.3	8.2	7.3	7.2	8.0	7.7	6.7	6.9	7.1
15-30	Males.....	8.7	8.6	8.5	....	9.1	7.4	8.3	8.0	8.0	6.4	7.1
	Females...	8.6	8.5	7.7	....	8.5	6.6	7.6	9.0	8.3	5.2	5 8
	Persons...	8.6	8.6	8.1	10.0	8.8	7.0	8.8	8.5	8.2	5.8	6.5
30-60	Males.....	13.1	19.9	17.8	....	16.5	16.0	16.1	13.5	16.3	14.1	11.6
	Females...	12.7	18.8	16.3	....	17.8	14.8	14.7	13.3	15.0	11.2	10.4
	Persons ...	12.9	19.4	17.0	17.3	17.2	15.4	15.4	13.4	15.6	12.5	11.0
60+	Males.....	67.8	81.0	82.6	88.2	80.4	73.0	71.3	79.0	69.7	73.6	61.1
	Females...	68.4	76.0	85.4	88.2	82.0	72.5	68.7	79.0	66.0	67.2	57.1
	Persons...	68.2	78.1	84.0	88.2	81.5	72.7	70.1	79.0	67.9	70.0	58.9
All ages.	Males.....	23 1	37.8	34.9	31.0	30.6	26.7	25.7	23.5	23.9	21.5	19.0
	Females...	22.6	35.9	30.9	29.0	28.3	24.9	24.4	23.1	21.7	19 5	17.9
	Persons...	22.8	36.8	32.4	30.0	29.5	25.8	25.0	23.3	22.8	20.4	18.4

the foregoing table,[1] which shows the mean death-rates of both sexes, and of each sex, at all ages, and at several groups of ages, in several countries.

The ages are still further divided in the following table,[2] which gives the average annual rates of mortality in England and Wales, according to the returns of thirty-four years (1838–1871), for males and females, at all ages, and at twelve periods of life :

Ages.	Males.	Females.	Ages.	Males.	Females.
All ages	23.3	21.5	All ages......	23.3	21.5
0– 5	72.6	62.7	45–55	18.5	15.6
5–10	8.7	8.5	55–65	32.0	28.0
10–15	4.9	5.0	65–75	67.1	58.9
15–25	7.8	8.0	75–85	147.1	134.3
25–35	9.9	10.1	85–95	305.5	279.5
35–45	13.0	12.3	95 and upward.	441.1	430.4

This table shows that, although in England, as in other countries, the average death-rate of males at all ages is greater than that of females, at the ages 10 to 35 the mortality of females slightly exceeds that of males. This temporary greater mortality of females at the ages of puberty and of reproduction appears by the figures of the last table but one to be peculiar to England and Belgium. After the age of child-bearing the women everywhere die at a much lower rate than men.

Influence of locality.—The variations of mortality, according to differences of locality, are extremely interesting to the hygienist, on account of the light which such variations, when properly interpreted, throw upon the nature of insanitary conditions. The general death-rate of a people

	Death-rates per 1,000.	
	Males.	Females.
Fifty-one healthy districts....................	17.56	16.23
England and Wales........,.................	23.61	21.28
London.......................................	26.55	22.34
Manchester district.........................	35.38	30.46
Liverpool district	40.97	36.36

[1] From M. Block : Loc. cit., p. 444. The figures are borrowed in part from Bertillon. The death-rates are calculated from the returns of the years 1860–1865, except those relating to France, which are of the years 1857–1866, and those for Sweden of the years 1864-1870.

[2] From Supplement to Thirty-fifth Report of the Registrar-General, p. xxvi.

is an average of high and low death-rates. As a rule, high rates of mortality prevail in cities, low rates in the country. The table[1] on preceding page shows the extent of the variation of mortality in certain typical divisions of England and Wales during the period 1861–1870.

In fifteen great "town districts" (Manchester, Salford, Bradford, Birmingham, Sheffield, Leeds, Newcastle-upon-Tyne, Munster, Leicester, Gateshead, Bristol, Hull, Exeter, Worcester, and Shrewsbury) the average annual rate of mortality during ten years (1861–1870) was as high as 29.48 per 1,000 for males, 25.91 for females.

Thus we see that the death-rate ranges from 17 per 1,000 in the healthy districts to 37 per 1,000 in Liverpool. The controlling agency, to which these great differences of mortality are chiefly due, is the degree of concentration of the population. According to Dr. Wm. Farr[2] the mortality of districts increases with the density of their populations; not, however, in the direct proportion of their densities, but as the sixth root of their densities. The uniformity and accuracy of this law are very remarkable. Having calculated the death-rates of seven groups of districts from the densities (population to a square mile) of those groups, Dr. Farr found the deduced death-rates to approximate very closely the observed actual death-rates of the groups of districts. The calculated death-rates being 18.90, 19.16, 20.87, 25.02, 28.08, 37.70, 38.74; the corresponding observed rates were 16.75, 19.16, 21.88, 24.90, 28.08, 32.49, 38.62.

We have seen to what extent the mortality at all ages is influenced by density of population. The ill effects produced by undue concentration of inhabitants are much greater in the early years of life than in subsequent ages. Infants and young children are far more sensitive than adults to this insanitary agency, as the following figures,[3] relating to seven groups of English districts, show :

Persons to a square mile...	166	186	379	1718	4499	12,357	65,823
Death-rate at all ages.....	16.94	19.18	21.90	24.81	28.02	32.92	38.67
Death-rate under five	37.80	47.53	63.06	82.10	95.04	111.90	139.52

The figures in the last column of this table relate to Liverpool district. Comparing these figures to those for the healthy districts, it is found that, while the death-rate at all ages is increased 128.3 per cent., the death-rate under five is increased 269.1 per cent. To every 100 deaths at all ages, and to every 100 deaths under five, in the healthy districts, there are respectively in Liverpool 228 deaths at all ages and 369 deaths under five.

[1] From the Supplement to the Thirty-fifth Report of the Registrar-General, p. clx.

[2] Appendix to the Fifth Report of the Registrar-General, pp. 420–424. Also Supplement to the Thirty-fifth Report, p. xxiii.

[3] Extracted from Table 49, Supplement to Thirty-fifth Report of the Registrar-General, p. clix.

It is thus made plainly evident that the evil effects of overcrowding are chiefly felt in infancy.

Excessive density of population is a complex condition, implying a combination of many separate and distinguishable morbific agencies. The part played by each of these is capable of more or less accurate analysis and statement by means of vital statistics relating to the hygienic, social, and financial conditions prevailing in different communities. The methods and results of such investigations cannot here be set forth. We must content ourselves with the statement that overpopulation implies not only the prevalence of filthy surroundings, resulting from the difficulties of ventilation, of drainage and sewerage, caused by the too great proximity of man to man; it implies also the poverty of the overcrowded inhabitants, together with all the anti-hygienic conditions which, as causes or effects, accompany poverty, namely, privations of all sorts, intemperance, vice, ignorance.

Such being the agencies which, when combined, find their statistical expression and measure in "density of population," it would be a mistake to suppose that the relation of mortality to density, according to the ratio demonstrated by Dr. Farr, was an inexorable law, incapable of mitigation by stationary measures. The mere fact that the death-rate of England remains stationary, in spite of the constantly increasing concentration of the population, is, as Dr. Farr points out, a proof of the efficacy of sanitation, as carried out in that country.

An important precaution, which must always be borne in mind when the death-rates of different localities or communities are compared, consists in ascertaining whether their populations are sufficiently similar in age-distribution to admit of comparison. The mortality rates at all ages of rich and poor urban districts are often placed in opposition to each other without allowance being made for differences of age-distribution, which deprive the contrasts observed of all significance. Districts inhabited by the wealthy classes always contain a great excess of adults, of the ages in which low or moderate rates of mortality prevail. Infants and young children are comparatively few in number, partly because the birth-rate among the wealthy classes is not so high as among the poor, but chiefly because the families of the wealthy comprise large numbers of strong and able-bodied servants who are childless, or, if not childless, have children residing elsewhere. In the districts inhabited by the poor, on the other hand, where the birth-rate is high, and no servants are kept by the heads of families, there is a great proportion of infants and young children. The great mortality among these raises the death-rate of the population to which they belong. The only proper way of comparing, as regards mortality, groups of inhabitants so differently constituted, is to compare their respective death-rates at different ages of life.

Influence of marriage.—Statistics have been adduced to show that the mortality of unmarried life is greater than that of married life. Dr. Bertillon's tables, made up from the returns of France from 1856 to 1865, show that the death-rates of married adults are considerably lower than

those of the unmarried, the death-rates of the widowed being the highest of all. The following extract from his figures,[1] showing death-rates per 1,000 living of each sex in each of the three conditions of life, will suffice to illustrate the extent of the differences found to exist:

Ages.	Males.			Females.		
	Single.	Married.	Widowed.	Single.	Married.	Widowed.
20–25 ...	12.88	8.92	49.60	8.32	9.92	12.31
25–30 ...	10.17	6.24	21.84	9.02	8.98	23.62
30–35 ...	11.51	6.82	19.17	9.87	9.36	16.90
35–40 ...	13.15	7.52	17.50	10.87	9.29	15.03
40–45 ...	16.62	9.55	18.89	13.28	10.14	12.73
45–50 ...	19.60	11.47	22.20	15.71	10.69	13.30
50–55 ...	25.80	15.61	26.80	20.97	14.11	15.20
55–60 ...	32.10	21.50	34.17	26.90	19.29	24.47
60–65 ...	45.92	32.60	47.50	40.52	30.75	37.07
65–70 ...	58.50	44.80	62.97	58.30	45.30	53.50

The death-rate of the married is manifestly the lowest. The inference that married life is correspondingly more salubrious than unmarried life, and is a cause of longevity, can, however, hardly be considered as justified, unless it is proved that the classes whose death-rates are compared comprise individuals originally equally healthy. A very plausible explanation of the differences observed in the rates of mortality of married and unmarried persons has been found in the incontestable fact that it is, as a rule, the strong men and women who undertake matrimony and succeed in securing partners.

Influence of occupation.—The health of individuals engaged in different occupations has nowhere been so fully and so elaborately investigated as in England of late years, under the direction of Dr. Farr. The last supplement to the reports of the registrar-general contains an immense amount and variety of tabulated statistical information bearing upon this important and interesting subject. The following extracts from Dr. Farr's remarks[2] will suffice to give the reader an idea of the methods used in the inquiry, and of the results obtained. For more exact and detailed information, he must be referred to the statistical tables themselves.

"The mean age at death of people in different businesses often furnishes very erroneous indications, as it is affected as much by the ages at which people enter and leave, and by the increase or decrease of employment, as by the salubrity or insalubrity of any particular profession. The only way in which the mortality and the duration of life of miners, tailors, farmers, laborers, or any other class of men can be accurately determined, is to determine the ratio of deaths at each age to the living

[1] See article "Mariage," Dictionnaire Encyclopédique des sciences médicales, Paris; also, M. Block: Loc. cit., p. 446.

[2] Supplement to the Thirty-fifth Report of the Registrar-General, pp. lii–lviii.

during a certain time—in fact, to apply the same method to each class as is applied to determine the mortality and the mean lifetime of all classes in a town, in a district, or in the whole kingdom.

"The materials for such an inquiry, extending over all the recognized trades of the men of England, were in part supplied ten years ago in the Supplement to the Registrar-General's Twenty-fifth Annual Report; and it has now been deemed right to publish as a sequel the deaths in 1871 in the same classes, at ten different ages, in England and Wales, in each of its divisions, and in eighty town districts.

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"By adding these results of 1871 to those for the two years 1860 and 1861, a large basis of facts is obtained, and sufficient to enable us to determine the relative mortality of men of various ages in all the leading, numerous, and well-defined professions. The clerical work in the reduction of these census and registration tables is very great, and nothing analogous to it has yet been undertaken in any other country. The results fully justify the expenditure in the collection and analysis of the facts, which are now submitted to the hygienic student. They will repay his careful study of the mortality in its relations to the circumstances of every occupation.

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"I can only call attention here to some of the more remarkable results.

"The numerous, useful, and, as a body, respectable men, who supply the community with drinks, food, and entertainment in inns are shown to suffer more from fatal diseases than the members of almost any other known class. They might themselves institute a strict inquiry into its causes. But there can be little doubt that the deaths will be found to be due to delirium tremens and the many diseases induced or aggravated by excessive drinking. It seems to be well established that drinking small doses of alcoholic liquors, not only spirits, the most fatal of all the poisons, but wine and beer at frequent intervals, without food, is invariably prejudicial. When this is carried on from morning till late hours in the night, few stomachs—few brains—can stand it. The habit of indulgence is a slow suicide. The many deaths of publicans appear to prove this. Other trades indulge in the publican's practice to some extent, and to that extent share the same fate. The dangerous trades are made doubly dangerous by excesses.

"The clergy of the Established Church, Protestant ministers, Catholic priests, and barristers, all experience low rates of mortality from ages 25 to 45. The clergy lead a comfortable, temperate, domestic, moral life, in healthy parsonages, and their lives are good in the insurance sense. The young curate, compared with the young doctor, has less cares.

"The mortality of Catholic priests after the age of 55 is high; perhaps the effects of celibacy are then felt.

"Solicitors experience the full average mortality after the age of 35; the legal work is hard.

"Physicians and surgeons, from youth up to the age of 45, experience a mortality much above the average; after that age they do not approach the priesthood in health, but differ little from the average. Many young practitioners have hard struggles to encounter. They are in contact with the sick, are exposed to zymotic disease, and their rest is disturbed. In states of depression, deadly poisons are at hand. There is an excess of practitioners in cities. Country practitioners have to visit their patients in all weathers, at all hours. The causes from which the medical men suffer demand careful study.

"Chemists and druggists are younger than medical men, because pharmacy is a separate business, and is of more recent growth. Their mortality, like that of medical men, is high, and above the average, especially in the younger ages. Manufacturers of chemicals, dyes, and colors also experience a mortality above the average.

"Commercial clerks experience an exceptionally high rate of mortality. The rooms in which they work are generally close and ill ventilated. They often stoop at their desks. They require Sir John Lubbock's holidays.

"The railway service, taken collectively, experience a high rate of mortality, somewhat higher than medical men at advanced ages.

"Coachmen (not domestic servants) and cabmen experience nearly the same high mortality as the railway service, from the age of 20 to 35; after 35 the mortality is in still greater excess; the causes are probably drink, exposure to the weather and violent deaths. The mortality of housekeepers and grooms, is, without hard exercise, nearly as high at the ages of 25 and upwards, as the majority of coachmen.

"Veterinary surgeons and farriers of the age of 25 and upwards experience a very high rate of mortality; higher than physicians and surgeons.

"Gamekeepers offer an example of the healthiness of outdoor life; their mortality is very low. The exercise of genuine sport is no doubt as salutary to the amateur sportsman as it is to the professional descendant of the hunters of old.

"Publishers and booksellers fare well in life and health; they are generally masters, in better circumstances than their confederates, bookbinders and printers, including masters and men, who often work in badly ventilated rooms, and die at a rate of mortality exceeding the average.

"Tool, file, and sawmakers have among them the grinders, who suffer so much from sharp particles of stone and steel inhaled into their lungs; their mortality is still high, and at the ages 32–45 is excessively high.

"Coachmakers of all branches working in wood, iron, binding, and paint, up to the age of 45, experience a low rate of mortality; afterwards the mortality exceeds the average. They live in towns.

"Wheelwrights, working chiefly in wood, and scattered all over the kingdom, are healthy; their mortality is low at all ages.

"To carpenters, joiners, sawyers, and workers in wood generally the same observation may be extended; their mortality is low; their occupation is healthy.

"The mortality of the blacksmiths, also scattered over the country, and working in heat and iron, is higher than that of the wheelwright and carpenter.

"The carver and gilder suffers less than he did. But both he and the plumber and glazier require further protection against the metallic poisons. The mortality is high among them from age 35; but at the age of 45–55 it approaches 50 per cent. higher; at 55–65 it is near the ordinary mortality of men.

"The wool, silk, cotton manufacturing population no longer experience an exceptionally high mortality. Lord Shaftesbury and his enlightened colleagues must be gratified, if not entirely satisfied, with the success that has crowned their life-long labors. And it is creditable to the mill-owners to find the men and boys in their employ suffering less than many other people in towns.

"The people working in wool are the healthiest; at all the young ages their mortality is the lowest; at 45 and upwards the cotton-workers suffer much more than the workers in wool and silk.

"The mercers and drapers are not so healthy a class as could be desired; their mortality is above the average; especially is this the case from 25 to 45. Perhaps much of their indoor work is better suited to women than to young men.

"The hairdressers, barbers, and wigmakers, the English Figaros, living chiefly in cities, experience, according to these returns, high rates of mortality at all ages; and so do hatters.

"Shoemakers at all ages, except 20–25 and at advanced ages, experience a rate of mortality below the average.

"Tailors, on the contrary, die at rates much above the average. For their health, and for shoemakers, both classes counting more than 300,000 men, much remains to be done.

"Bakers experience a mortality very little above the average, and that is chiefly at advancing ages.

"Grocers at all ages after 35 experience a low rate of mortality.

"The tobacconists, snuff, and tobacco manufacturers suffer very much at all the

younger ages; indicating clearly enough how prejudicial smoking is to young men. They present a strong contrast at the corresponding ages to tanners and curriers, who are healthy up to 45, and then show signs of suffering.

"The earthenware manufacture is one of the unhealthiest trades in the country. At the age of joining it is low; but the mortality after the age of 35 approaches double the average; it is excessively high; it exceeds the mortality of publicans. What can be done to save the men dying so fast in the potteries, and engaged in one of our most useful manufactures?

"Among the glass manufacturers the mortality is higher at 25–35 than among the earthenware manufacturers; but it is lower afterwards.

"The men engaged in copper manufactures from 20 and upwards experience a mortality somewhat above the average; at 55 to 75 their death-rate is heavy—much heavier than it is among the workers in brass and in iron.

"The men in the iron manufactures do not die at the average rates under 45; after that age the average is exceeded.

"Working in wood, on the whole, is comparatively cool compared with working in iron; the loss by perspiration is excessive among such men as puddlers, and they require a great deal of drink, which should contain little or no alcohol.

"Taken in the aggregate, the metal worker—the metallic man in all England does not experience the average rate of mortality under 45; after that age the table turns against him and his losses grow heavier and heavier every year.

"Miners, in the aggregate, experience a heavier rate of mortality, largely from violent death, than metal workers; and the mortality of both classes greatly exceeds that of the agricultural laborer.

"Independently of the influence of the material and of the work itself on health, the place in which men work exercises so great an influence that it has to be taken into account in judging of the salubrity of their occupations.

"Man is naturally an open air-animal; he is made to work, and the sky is his native covering. So, after taking everything into account, the hunter, the sportsman, and the husbandman in a cultivated land are at present the healthiest of all workmen. All would no doubt be the better if the higher parts of the brain had their due share of activity; and this, though not often the case now, we may hope will come.

"The farmers and agricultural laborers are at present among the healthiest classes of the population, classified according to occupation. The young farmer, for some reason or other, suffers a higher mortality than the laborer; but at 35 and upwards the British farmer enjoys comforts which are beyond the reach of the laborer. It is probable that in no country the agricultural population is healthier than in England. . . . . The mortality of the English farmer is not now high; but it may by care be reduced to a lower figure. To what is the high mortality of the young farmer of 15–25 due? Farmers' sons appear to be healthy. The laborer experiences a higher rate of mortality than the farmer at all ages after 35."

The causes of death.—The death-certificates obtained by means of registration should state in every case, in terms belonging to the accepted nomenclature, the nature of the disease proving fatal. These returns having been collected by the registrar, and purified by the careful rejection of such certificates as fail for any reason (such, for instance, as the unprofessional character of the informant) to afford sufficient guarantees of accuracy, are then classified and enumerated. From the numbers so obtained, various kinds of ratios are calculated, taking the form either of special death-rates showing the mortality by each disease or class of diseases per 1,000 living, or of percentages showing the number of deaths by each disease or class of diseases in every 100 deaths. Of these two

TABLE OF MORTALITY, DERIVED FROM THE ENGLISH LIFE-TABLE, BORN CHILDREN MAY

AGES.	ALL AGES	0–5	5–10	10–15	15–20	20–25
DEATHS FROM ALL CAUSES.	1,000,000	263,182	34,309	17,946	21,813	28,705
TOTAL ZYMOTIC DISEASES. ORDER 1.	175,619	87,099	19,256	6,555	4,717	4,554
ZYMOTIC DISEASES. ORDER 1.						
1. Small-pox	6,521	3,331	833	244	291	456
2. Measles	12,865	11,507	1,080	127	39	29
3. Scarlatina	30,021	17,959	8,743	1,901	493	283
4. Diphtheria	4,945	2,425	1,364	464	165	100
5. Whooping-cough	15,161	14,424	682	35	6	2
6. Typhus	38,107	5,401	4,036	2,842	2,907	2,696
7. Diarrhœa and dysentery	34,366	20,344	427	154	141	244
8. Cholera	6,155	1,129	382	173	134	215
9. Other zymotic diseases. Order 1.	27,478	10,579	1,709	615	541	529
FIVE CONSTITUTIONAL DISEASES.						
10. Cancer	21,311	71	35	31	58	100
11. Scrofula and tabes	14,106	8,115	1,100	811	633	541
12. Phthisis.	114,417	4,469	2,139	3,526	9,074	13,785
13. Hydrocephalus	11,252	9,296	1,363	362	84	32
LOCAL DISEASES.						
14. Diseases of the brain	121,859	40,065	2,406	1,303	1,275	1,464
15. Diseases of the heart and dropsy.	76,660	1,507	938	1,005	1,080	1,255
16. Diseases of the lungs	149,585	41,476	2,397	837	1,056	1,577
17. Diseases of the stomach and liver.	52,497	4,778	936	717	844	1,137
18. Diseases of the kidneys	14,910	301	215	179	234	351
19. Diseases of the generative organs.	3,062	20	2	6	26	85
20. Diseases of the joints	3,395	243	292	312	270	219
21. Diseases of the skin	2,512	663	46	42	39	50
22. CHILDBIRTH AND METRIA	6,921	....	....	....	244	1,100
VIOLENT DEATHS.						
23. Suicide	3,479	....	....	14	94	150
24. Other violent deaths	30,052	5,175	2,069	1,703	1,580	1,677
25. OTHER CAUSES	198,363	59,904	1,115	543	505	628

SHOWING OF WHAT DISEASES AND AT WHAT AGES 1,000,000 LIVE-BE EXPECTED TO DIE.

25–35	35–41	45–55	55–65	65–75	75–85	85	AGES.
62,052	69,078	81,800	112,086	147,905	122,559	38,565	DEATHS FROM ALL CAUSES.
7,918	7,616	8,101	9,795	11,256	7,229	1,528	TOTAL ZYMOTIC DIS. ORDER 1.
							ZYMOTIC DISEASES. ORDER 1.
624	347	210	113	53	16	3	1. Small-pox.
41	23	11	5	2	1	....	2. Measles.
330	162	80	45	19	6	....	3. Scarlatina.
125	91	74	68	47	19	3	4. Diphtheria.
4	2	2	2	2	....	....	5. Whooping-cough.
4,197	3,777	3,749	3,822	3,233	1,287	160	6. Typhus.
664	776	1,115	2,162	3,883	3,551	905	7. Diarrhœa and dysentery.
640	781	829	865	688	281	38	8. Cholera.
1,293	1,657	2,031	2,713	3,329	2,068	414	9. Other zymotics. Order 1.
							FIVE CONSTITUTIONAL DISEASES.
682	2,290	4,583	5,998	5,122	2,040	301	10. Cancer.
815	576	542	511	361	93	8	11. Scrofula and tabes.
27,134	22,404	16,468	10,445	4,294	627	52	12. Phthisis.
36	24	20	18	12	5	....	13. Hydrocephalus.
							LOCAL DISEASES.
3,844	5,941	9,313	15,678	23,108	14,974	2,488	14. Diseases of the brain.
3,829	6,261	10,041	17,081	21,579	10,781	1,303	15. Diseases of the heart & dropsy.
4,479	7,452	13,203	23,659	31,213	18,726	3,510	16. Diseases of the lungs.
3,165	5,032	7,917	11,400	11,389	4,619	563	17. Diseases of the stomach & liver.
1,072	1,495	1,982	2,332	3,785	2,154	310	18. Diseases of the kidneys.
324	585	750	657	450	141	16	19. Diseases of the gen'tive organs.
357	349	390	438	379	131	15	20. Diseases of the joints.
110	143	214	344	488	312	61	21. Diseases of the skin.
2,901	2,516	160	....	....	....	....	22. CHILDBIRTH AND METRIA.
							VIOLENT DEATHS.
391	564	803	826	492	131	14	23. Suicide.
3,301	3,280	3,354	3,155	2,572	1,691	495	24. Other violent deaths.
1,694	2,550	3,959	9,249	31,405	58,905	27,906	25. OTHER CAUSES.

methods of statement the former is preferable. Percentages are less trustworthy indications of the degree to which fatal diseases prevail than death-rates based upon the living population, because the former constitute ratios between two factors of which both are variable, namely, the mortality by a specified disease, and the mortality by all causes.

The value of the statistical statements so obtained depends upon the accuracy with which the nature of the fatal diseases is habitually diagnosticated and registered by the members of the medical profession; upon the completeness with which the registration laws are executed; upon the care and skill with which the necessary rejections of unsuitable certificates, the classification, and the mathematical operations are effected by the registrar. All these steps in the elaboration of the statistics being supposed to be successfully performed, the results must then be correctly interpreted, in order that their significance may be elucidated.

In no country are the causes of death so accurately, so completely, and so uniformly registered as in England, and nowhere are the vital statistics relating to this subject so elaborately developed as in the admirable records of the registrar-general. We shall again have recourse to this source for illustrations of the statistical results afforded by registration of the cause of death. The table of mortality [1] (pp. 328, 329), derived from the English life-table, shows of what diseases, and at what ages, a million live-born children may be expected to die.

From the returns relating to the causes of death in England and Wales for the twenty years 1851–1870, used in combination with the figures of the English life-table, and tabulated in the last supplement to the Registrar-General's Reports, Dr. Farr has drawn up a description of the "March of an English Generation through Life," in which he follows a million people through the whole of their ages, and points out the casualties under which past experience shows that they are likely to succumb. So much valuable information, drawn from the most trustworthy collections of vital statistics in the world, is condensed in this graphic account of the diseases which prove fatal at different periods of life, that we cannot resist the temptation to reproduce it here in the words of its distinguished author.

"*March of an English Generation through Life.*[2]

"*Age* 0–5.—The first thing to observe is that the fatality children encounter is primarily due to the changes in themselves. Thus 1,000,000 children just born are alive, but some of them have been born prematurely; they are feeble; they are unfinished; the molecules and fibres of brain, muscle, bone, are loosely strung together; the heart and blood, on which life depends, have undergone a complete revolution; the lungs are only just called into play. The baby is helpless; for his food and all his wants he de-

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[1] From the Supplement to the Thirty-fifth Report of the Registrar-General, Table 7, p. xciv. In this table *metria*, or puerperal fever, is removed from the zymotic diseases, and returned in conjunction with childbirth.

[2] From the Supplement to the Thirty-fifth Report of the Registrar-General, p. xxviii. et seq.

pends on others. It is not surprising then that a certain number of infants should die; but in England the actual deaths in the first year of life are 140,493, including premature births, deaths by debility and atrophy; diseases of the nervous system 30,637, and of the respiratory organs, 21,995. To convulsions, diarrhœa, pneumonia, bronchitis, chiefly their deaths are ascribed; little is positively known; and this implies little more than that the brain and spinal marrow, nerves, muscles, lungs, and bowels fail to execute their functions with the exact rhythm of life. The first two are said by pathologists to be often rather symptoms of diseases than diseases in themselves. The total dying by miasmatic diseases is 31,266; but it is quite possible that several of the children dying of convulsions die in the early stages of some unrevealed zymotic disease, whose symptoms have not had time for development. . . . Many of the cases of pneumonia may also in like manner be whooping-coughs and other latent zymotic diseases. In the second year of life pneumonia, bronchitis, and convulsions are still the prevalent, and most fatal diseases; many also die then of measles, whooping-cough, scarlatina, and diarrhœa. Scarlet fever asserts its supremacy in the second, third, fourth, and fifth years of age. Whooping-cough is at its maximum in the first year, measles in the second, scarlatina in the third and fourth years. Thus these diseases take up their attacks on life in succession, and follow it onwards.

"The deaths from all causes under the age of five years are 263,182. The number ascribed to infanticide is very few; but the deaths by suffocation (overlaying, etc.), are more numerous; and so are the deaths directly referred to the 'want of breast-milk.' The total deaths by burns, injuries, drowning, and all other kinds of violence, are 5,175.

"By a physiological law 511,745 boys are born in England to 488,255 girls; and by another law 141,387 boys and 121,795 girls die in the first five years of life; so that at the end of five years, the original disparity in the numbers of the two sexes is so much reduced that at the age of five years the boys only slightly exceed the girls in number. The greater mortality of boys is due to difference of organization, for the external conditions are substantially the same in which boys and girls are placed.

"Great as is the influence of organization itself, the differences of external circumstances and sanitary condition exercise a very real influence on life, disease, and death in childhood.

"Thus, even in the Healthy Districts of the country, out of 1,000,000 born, 175,410 children die in the first five years of life; but in Liverpool District, which serves to represent the most unfavorable sanitary conditions, out of the same number born 460,370, nearly half the number born, die in the five years following their birth. This is 284,960 in excess of the deaths in the healthy districts.

. . . .

"*Age* 5–10.—Our young travellers now enter on their *sixth year* of life. They have left great numbers on the way; and nearly every one of the 736,818 survivors has been attacked by one disease or another, some by several diseases in succession. There is one fact in their favor; the majority of the zymotic diseases rarely recur. Each renders the body insusceptible of injury from diseases of its own kind, though not from other diseases. Medicine is still without any accurate determination of the numbers attacked to every death, but it is evident from the deaths that some hundreds of thousands of the survivors have had whooping-cough, measles, scarlet fever. Taking advantage of the non-recurrent law, Jenner, by his immortal discovery, substituted small-pox modified and mild for natural small-pox; and it is probable that the greater part of all the children at the age of five are vaccinated or have had small-pox.

"So the total deaths in the five years following are 34,309, 8,743 of them from scarlatina, the principal plague of this age; 1,364 from diphtheria, 4,036 from fever. More than half of the deaths in this young age are from miasmatic disease; in all, 19,256. The brain and lung diseases levy also a certain tribute.

"*Age* 10–15.—But 702,509 survive and enter on this age, which culminates in puberty, and 684,563 pass through it into the next at the age of 15, for the deaths are fewer than at any other age. They amount to 17,946, of which 1,901 are by scarla-

tina, 2,842 by fever, 3,526 by phthisis, these last two diseases already standing as the most deadly. In this period the change in girls is greater than the change in boys, and rather more of them die.

"*Age* 15–20.—Now the mortality increases, especially among women, of whom 5,263 die of consumption (phthisis), and 244 of child-birth, for at this age a few young girls marry with some risk to their lives. The tight ligatures that are so often and so unwisely placed around the waist interfere with respiration, and may, with their in-door life, favor the development of phthisis. The deaths of males by consumption are 3,811, by fever, 1,368; the deaths from both diseases being fewer than the deaths of females from the same causes. The violent deaths of 1,387 males against 193 females go a long way towards redressing the inequality.

"Melancholy suicide appears now among the causes of death; indeed 14 such deaths appear before the age of 15, but the numbers in this age amount to 94, of whom 46 are males, 48 are females. Insanity looms on the horizon, and there is an excess of fatal brain affections over affections either of the heart or lungs.

"*Age* 20–25.—At this age large numbers marry. The deaths are 28,705, of which nearly half, or no less than 13,785, are by phthisis. Fever is associated with it as the great prevailing zymotic disease; the reign of the other zymoses of the young is almost over. The brain, heart, and lungs begin again to suffer and of their diseases more die. 1,100 women die in child-birth.

"If it is the age of love it is also the age of war, of dangerous work, and of crime. The violent deaths, exclusive of suicides, are 1,677, without reckoning any death in foreign war.

"*Age* 25–35.—Of the million 634,045 attain the age of 25, and 571,993 live to the age of 35. The period extends over double the time hitherto handled. It is the athletic, the poetic age; it is the prime of life. Two thirds of the women are married; and now, at its close, is the mean of the period (33–34) when husbands become fathers, wives become mothers, the new generation is put forth. The deaths are separations; they leave widows and fatherless children behind. Of the 62,052 that die 30,592 are men, 31,460 women; 2,992 of the men, and only 309 of the women, die by violence, suicide excepted; but 2,901 women die in child-birth.

"Consumption is the most fatal disease of the age; it is the cause of 27,134 deaths, women suffering more than men Fever is fatal to fewer lives than it was earlier, but it is by far the most fatal of the zymotic diseases and slays its 4,197.

"The local diseases of lungs, heart, and brain grow intenser in this period.

"We may look back to the fate of a generation exposed to unfavorable conditions, such, for instance, as prevailed in the Liverpool District. There, of a million born, less than half—only 434,497—live to the age of 25; then 74,153 die in the ten years, leaving 360,344 alive at the age of 35. No less than 10,657 die of fever, 333 of suicide, 4,850 of other violent deaths. The local diseases are exceedingly fatal; 1,938 mothers die in child-birth.

"In happier sanitary conditions 727,552 live to the age of 25, and 667,940 survive the age of 35. Only 3,116 die of fever, 396 of suicide, and 2,819 of other violent deaths.

"*Age* 35–45.—The losses are of 69,078 lives; 35,142 men, 33,936 women. The athletic age is now over, but the combined faculties of muscular and nervous energy are at their height. Women have borne more than half their children, now they bear the rest. It is the age of fathers and mothers. Criminality declines. Many of the structures now give way. Phthisis still predominates; fever snatches still its many victims, and the brain, heart, lungs, and bowels become more and more the seats of destructive disease; 564 persons commit suicide; 3,280 die violent deaths; 2,907 of them men and 373 women; 2,516 mothers die in child-birth.

"While the deaths by fever are 3.777 out of 571,993 attaining this age in England, 14,322 people die of it in the Liverpool district out of 360,344. The lung diseases in the two sets of conditions are fatal to 7,452 and 13,967 lives.

"In the healthy districts the deaths by fever are 2,702, by diseases of the lungs, 5,261.

"*Age* 45–55. —This age is the middle arch of life : *Nel mezzo del cammin di nostra vita*, for the million are reduced to half a million lives a few months after the age of 45. They have produced the succeeding generation. The age of fertility is now nearly over in women; but a few lingerers bear children, and in the act 160 die. The deaths by all causes are 81,800; by fever, 3,749; diarrhœa, dysentery, and cholera, 1,944; by phthisis, 16,468; by lung diseases, 13,203; heart diseases and dropsy, 10,041; brain diseases, 9,313; bowel and liver diseases, 7,917. The centres of life are sources of death. At this age, in their wretchedness, and in their weakness, 599 men, 204 women, in all 803, appeal rashly to the "arbitrator of despairs, just death." 2,876 men, 478 women, in all 3,354 persons die violent deaths.

"Cancer, a formidable and dread disease, that began to be fatal before, now destroys 4,583 lives—1,140 men, 3,443 women.

"In unfavorable sanitary conditions, out of a million lives in Liverpool, only 275,193 attain the age of 45, and 90,696 die in the following ten years; 12,504 of fever, 13,274 of phthisis, 24,417 of pulmonary diseases, 420 of suicide, and 4,314 of other violent deaths.

"In the Healthy Districts of the country, 606,019 attain the age of 45, and 71,938 die in the ten years following; 2,306 by fever, 13,745 by phthisis, 10,012 by brain diseases, 10,451 by heart diseases and dropsy, 8,234 by pulmonary diseases, 1,022 by suicide, and 3,030 by other violent deaths.

"*Age* 55 *and upwards*.—To the age of 55, near the middle of the possible lifetime of humanity in its present state, 421,115 attain; and from this point of time it is possible to look ahead, and discover the particular rocks, foes, collisions, tempests to be encountered, to be dreaded, or to be weathered by the fleet on its way to the utmost butt of existence—"the very seamark of its journey's end."

"One thing to remark is, that the rate, the degree of danger, which has hitherto increased slowly, now increases at so much faster a pace that, although the number of lives grows less, the number of deaths increases in every one of the next twenty years, and is afterwards sustained for ten years longer, until at last, in the distance, the living all sink into the elements from which they came.

"Few will die of the non-recurrent zymotic diseases; some 29,803 in all will die of fever, diarrhœa, cholera, rheumatism, and other zymotic diseases; cancer will carry off almost as many as phthisis; the greatest mortality, however, will be experienced from diseases of the lungs; then will follow in their wake of destruction brain affections, apoplexies, paralyses, heart and artery diseases, often the remote causes of the other maladies; bowel and liver diseases, kidney diseases; many will still die violent deaths, as they are less able to resist injuries than younger lives; gout and intemperance will reap their later harvest; so will mortification, atrophy, debility, and the infirmities of old age. then comes the end.

"Of 100 women living, of the age of 55 and upwards, it is worthy of note that 11 are spinsters, 43 widows, and 46 wives; of 100 men, 9 are bachelors, 24 widowers, 67 husbands. We now pass to the particular decenniads of life.

"*Age* 55–65.—The number of males and females surviving becomes equal at the age of 53; but at and after 55 the women exceed the men in number as their mortality-rate is lower even after the age of 39. While 421,115 of both sexes enter this stage of life, 309,029 live on to the next; 112,086 die; only 9,795 of fever, diarrhœa, dysentery, cholera, rheumatism, and other zymotic diseases. Cancer kills 5,998 persons, 4,035 of these women; consumption 10,445; the diseases most to be dreaded and guarded against, especially by men, are affections of the lungs and heart, of which 23,659 and 17,081 persons die; diseases of the brain are fatal to 15,678, of the stomach, intestines, and liver are fatal to 11,400. The vigor of life is somewhat subsiding; family cares, perhaps, accumulate, ambition is disappointed, and the mind sometimes gives way organically; the tendency to suicide is greatest at this age, and the greatest num-

ber of lives, 826, come to that melancholy close in this period. But 3,155 are killed by violent deaths of various kinds—2,560 men, 595 women.

"*Age* 65–75.—309,029 enter this age, and 161,124 leave it alive; 67 years is near the mean date at which their children give birth to their grandchildren, the third generation. The 147,905 dying in this period succumb to the same classes of diseases as were fatal in the previous decenniad; and still more succumb to lesions of the brain, and heart, and lungs; the kidneys give way, but are never so fatal as affections of the higher organs; 11,256 of the deaths are from fever, diarrhœa, cholera, rheumatism, and other diseases of the miasmatic order; 9,789 from five constitutional diseases; 92,391 from diseases of brain, heart, lungs, and other local organs; 3,064 from violence; and there remain 31,405 referable in great part to a new head in the developmental class, *old age.*

"The year of age 72 is that in which the greatest number of *men* die, which may have led the psalmist to say, the days of the years of our life are three score and ten; but these are "days passed away in thy wrath," in violation of the divine laws, and therefore are not necessarily the limit of healthy existence when the laws of life are observed.

"*Age* 75–85.—The numbers that enter this decenniad are 161,124, and the numbers that leave it alive are 38,565. More than half the numbers living have been married and are widowed. The 122,559 that die of recognized disease at this age die chiefly of lung, brain, heart, and other local diseases; against such dangers they have to guard themselves. The number of such deaths is 51,838; then some 7,229 persons die of miasmatic diseases, 131 of suicide, 1,691 of violence. The cold weather is their great foe. But there remain 58,905, dying chiefly of atrophy, debility, and *old age.*

"*Age* 85 *to the end.*—The 38,565 aged pilgrims are no longer what they were; their strength is fading away and they succumb to slight injuries, to cold, heat, want, or attacks which in their early years would have been shaken off; only 2,153 live to the age of 95 and 223 to 100; finally, by this table, at the age of 108, one solitary life dies.

"Of what causes do they all die? Diseases grow again as obscure as they were in infancy; zymotic diseases, constitutional diseases scarcely appear; the diseases of the lungs and brain are the most conspicuous among the local diseases; 509 die of violent deaths, including suicides. These causes account for the end of 10,659, leaving 27,906 that die chiefly of *old age*—of what has been called natural death. . . . .

"Such and so various are the settings of forty million eight hundred and fifty-eight thousand one hundred and eighty-four years of English life."

In the United States the causes of death, as exhibited in registration reports, differ in some respects from those recorded in England.

In the first place, a greater fatality reigns among infants in this country, especially in our great cities, whose death-rates are largely increased by the excess of infant mortality. The following figures, relating to two cities whose rates of mortality at all ages are nearly identical, afford an illustration of the difference in the rates prevailing at ages under and over five years in English and American cities:

AGES.	BOSTON: Means of the last four census years.	LONDON: Means of ten years, 1861–1870.
Death-rates under five	97.2	81.6
Death-rates over five	15.2	15.7
Death-rates at all ages	24.4	24.3

The excess of infant mortality in American cities is chiefly due to summer diarrhœa (commonly called *cholera infantum*), and is doubtless caused by the intense heat of our summers.

Another important feature of vital statistics in many parts of the United States, particularly, however, in New England, is the great mortality by consumption. Comparing the records obtained in Massachusetts, for example, with those of England, we find that, while the mean death-rate from phthisis in England during 25 years (1850–1874) was 2.58 per 1,000, the rate for 1875 being 2.22, in Massachusetts the mean death-rate during 24 years (1853–1876) was as high as 3.65 per 1,000, the rate for 1875 being 3.47.[1]

The mortality caused by phthisis in Massachusetts has been steadily growing less year by year. In 1853 the death-rate by this disease stood as high as 4.27 per 1,000 ; during the ten years 1853–1864 the decennial mean death-rate was 3.89 ; during the succeeding ten years, 1865–1876, the decennial mean was 3.40, and in 1876 the death-rate was 3.15. Various causes have been assigned to explain the improvement of the public health made manifest in these figures. We cannot here discuss the correctness of the explanations that have been brought forward, but we shall have occasion to touch upon this subject of inquiry in connection with the influence exerted by *nationality* upon mortality in this country.

The last peculiarity of the mortality records of the United States, to which we shall only allude, is the occasional prevalence of an epidemic disease which is almost unknown in Europe, namely, *yellow fever*. For information respecting the ravages occasioned by this very fatal disease in certain sections of the country, the reader must be referred to the chapters of this work which treat of External and Inland Quarantine.

Influence of nationality upon mortality.—We now come to a most important and interesting subject of inquiry. The population of the United States, being largely recruited by immigration, contains a great proportion of foreign-born inhabitants. These amounted in 1870, according to the last national census, to 14.4 per cent. of the aggregate population of the country, and consisted mainly of Irish (4.8 per cent.), of Germans (4.4 per cent.), of English and Welsh (1.6 per cent.). Of all the other nationalities, amounting together to 3.6 per cent., no one attained 1 per cent. Or, taking the foreign population by itself, the proportions of the predominating races were as follows : Irish, 33.3 per cent. of all foreigners ; Germans, 30.3 per cent. ; English and Welsh, 11.2 per cent. ; all other foreigners together, 25.2 per cent.

These foreign-born inhabitants, with their families, are mostly concentrated in the cities. Thus, in 1870, of the population of New York 45.5 per cent. were foreign-born, 21.4 per cent. being Irish. Philadelphia contained 27.25 per cent. of foreigners, the percentage of Irish being 14.3. Boston had 35.12 per cent. of foreigners, the Irish amounting to 22.71 per cent. Of the entire foreign-born population of Boston 64.6 per cent.

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[1] Thirty-fifth Registration Report of Massachusetts, Boston, 1877, p. 70.

were Irish, people from the British American provinces (15.4 per cent.), Germans (6.3 per cent.), English (6.1 per cent.), Scotch (2.0 per cent.), and other foreign nationalities (each falling short of 1 per cent.) composing the remainder of the foreign-born population of the city. By the State census of 1875 the percentage of foreigners in Boston was 34.2; the Irish amounted to 20.42 per cent. of the entire population of the city, and to 59.66 per cent. of the foreign-born. The importance of these ingredients of our populations is sufficiently manifest, and it becomes interesting to inquire how they affect the sanitary condition of the communities in which they are established.

The most important contribution toward the solution of this question was made by General F. A. Walker,[1] the superintendent of the last national census, in a valuable paper on The Relations of Race and Nationality to Mortality in the United States. It is very difficult correctly to institute comparisons between the mortality of the natives and that of the foreigners, on account of the anomalous age-distribution of the populations concerned in the comparison. Death-rates cannot, therefore, be resorted to in such an inquiry. But, as General Walker has shown, different foreign classes of this country can fairly enough be compared among themselves, without its being necessary for us to take into account age-distribution, since all these groups are constituted in a nearly uniform manner, and are, therefore, as regards age-distribution, all on about the same footing.

Table No. 1 (on opposite page), drawn up by General Walker, shows, in a clear light, the differences which exist among the foreign populations, compared among themselves, as regards mortality by all causes, and by certain of the most important diseases, and classes of diseases.

The figures contained in General Walker's table should be interpreted on the basis of the proportions borne by the different foreign nationalities to the aggregate foreign population of the United States, as shown in table No. 2, which is, so to speak, the key to the preceding table.

General Walker's table, then, should be interpreted in the following manner: if each and all of the races therein tabulated were equally liable to death and to each of the specified diseases, each race would contribute equally to population and to mortality, and the same figures would express its proportion of the aggregate foreign population and of the total foreign decedents. The Irish, who constitute exactly a third part of the foreign population of the United States, would also contribute a third part, 333 in 1,000, of the deaths by all diseases, or by any one disease. But it will be seen in the table that in reality the Irish considerably exceed their quota (333 in 1,000) of deaths, inasmuch as they contribute as many as 410 to every 1,000 foreign-born decedents. The Germans, on the other hand, who number 303 in every 1,000 foreigners living in this country,

[1] Publications of the American Public Health Association for 1873, New York, 1875, p. 35 et seq.

only furnish 282 out of every 1,000 deaths of foreigners; their general liability to death is therefore comparatively slight. Thus, whenever any nationality contributes more largely to deaths than to population among

(TABLE No. 1.)

DISEASES.	Total foreign decedents.	Irish.	Germans.	English and Welsh.	Swedes, Norwegians and Danes.	Scotch.	French.
All diseases	1,000	410	282	108	34	27	25
General diseases—A (febrile)	1,000	282	329	101	78	22	23
General diseases—B (constitutional)	1,000	454	276	90	24	26	23
Diseases circulatory system	1,000	431	279	134	18	26	30
Diseases urinary system and organs of generation	1,000	442	289	108	22	25	21
Diseases respiratory system	1,000	408	287	112	29	27	29
Diseases digestive system	1,000	379	280	121	51	28	27
Diseases organs of locomotion	1,000	477	231	108	28	38	33
Diseases nervous system	1,000	378	292	142	21	36	27
Diseases integumentary system	1,000	417	236	160	17	27	22
Conditions not necessarily associated with general or local diseases	1,000	478	260	101	12	32	27
Accidents and injuries	1,000	424	251	125	30	23	22
Other and unknown	1,000	461	243	88	38	23	20
Bright's disease	1,000	576	213	110	13	28	8
Apoplexy	1,000	381	328	139	9	28	34
Cancers	1,000	412	307	117	11	41	39
Consumption	1,000	478	262	84	25	24	20
Rheumatism	1,000	392	284	103	39	30	36
Paralysis	1,000	409	253	173	11	41	26
Cerebro-spinal, enteric and typhus fevers	1,000	302	332	90	88	20	24
Pleurisy and hydrothorax	1,000	380	299	99	19	36	43
Bronchitis	1,000	534	228	87	16	25	31
Small-pox	1,000	203	441	36	25	3	24
Pneumonia	1,000	413	284	116	27	29	29
Diarrhœa, dysentery and enteritis	1,000	384	271	118	66	30	28
Erysipelas	1,000	358	309	133	29	44	23
Intermittent and remittent fevers	1,000	328	335	83	34	18	45
Encephalitis and meningitis	1,000	332	301	121	38	34	21
Scarlet fever and diphtheria	1,000	192	283	189	75	28	7
Measles	1,000	175	240	123	255	39	8
Scrofula	1,000	287	218	113	78	17	26
Hydrocephalus	1,000	277	231	139	15	23	31
Croup	1,000	163	366	159	64	25	10
Whooping-cough	1,000	153	254	161	178	68	..

(TABLE No. 2.)

FOREIGN POPULATION OF THE UNITED STATES IN 1870.

Total foreigners.	Irish.	Germans.	English and Welsh.	Swedes, Norwegians, and Danes.	Scotch.	French.
1,000	333	303	112	43	25	21

foreigners, the excess is significant of a disproportionate liability to death by the disease specified, and, conversely, whenever the proportion of any nationality to the aggregate foreign population exceeds its proportion to the aggregate deaths occurring among foreigners, then that nationality may be said to enjoy a comparative exemption from the diseases specified. The degree of liability or of exemption may be measured by the difference between the contributions to population and to mortality.

In the following statement, embodying the conclusions drawn by him from his figures, General Walker sets forth in a summary manner the peculiarities of each of the leading foreign nationalities which enter into the composition of the population of this country. As interpreted by its author, the table shows:

"*Among the Irish*, a comparative exemption from all the general diseases of the febrile group, and from diseases of the digestive and nervous systems; and, on the other hand, a marked liability to general diseases of the constitutional group, including consumption, but with exception of rheumatism, scrofula, and cancers, and to diseases of the orgaus of locomotion, and of the urinary system, with extraordinary mortality from Bright's disease of the kidneys.

"*Among the Germans*, a reduced mortality from general diseases of the constitutional group, and a decided liability to those, especially small-pox, of the febrile group (being an exact reversal of the relations of the Irish thereto); a comparative immunity from diseases of the organs of locomotion, and of the integumentary system, and, otherwise, a general evenness in the distribution of the body of deaths among the several groups of diseases, and through the list of specific diseases.

"*Among the English and Welsh*, a liability to the diseases of the nervous, circulatory, digestive, and integumentary systems coutrasted with comparative immunity from general diseases, both of the febrile and the constitutional groups; of the specific diseases, scarlet fever, diphtheria, whooping-cough, hydrocephalus, croup, erysipelas, apoplexy, and paralysis, being relatively most fatal; and consumption, intermittent and remittent, cerebro-spinal, enteric, and typhus fevers, bronchitis, and small-pox, least fatal.

"*Among the Swedes, Norwegians, and Danes*, a marked liability to diseases of the digestive system, especially dysentery, diarrhœa, and enteritis, and an extraordinary mortality from general diseases of the febrile group, notably, measles, scarlet fever, diphtheria, and typhus, enteric and cerebro-spinal fevers, with comparative immunity from general diseases of the constitutional group, and from diseases of the circulatory, nervous, urinary, and integumentary systems, and of the organs of locomotion; the deaths from cancers, apoplexy, paralysis, bronchitis, hydrocephalus, and Bright's disease of the kidneys being remarkably small.

"*Among the Scotch*, an evenness in the distribution of the body of deaths among the several groups, with marked exception only of the diseases of the nervous system, and of the organs of locomotion, the most noticeable exemptions among the specific diseases being small-pox, scrofula, and the fevers; the most noticeable instances of liability, cancers, paralysis, measles, and whooping-cough.

"*Among the French*, a general evenness in the distribution of the body of deaths among the several groups of diseases, with somewhat more of irregularity as to the distribution among the specific diseases than among the Scotch."

Certain of the national peculiarities to which attention has been directed by General Walker are displayed in the vital statistics of our cities. In Boston, where the Irish so predominate as to exceed in number all the other foreigners put together, they contributed, in 1865, to the foreign

population 70.2 per cent., to the total mortality among foreigners 76 per cent., and to deaths by consumption among foreigners 77.9 per cent. In 1870 the corresponding percentages were 64.6, 73.2, and 76.2. Similar facts have been observed in New York.[1]

The proportion of Irish inhabitants in this country has been diminishing steadily for a number of years back. In the State of Massachusetts, the proportion of Irish in 1855 was 16 per cent. of the total population; in 1875 it was 14.2 per cent. In Boston the Irish amounted, in 1855, to 28.8 per cent.; in 1875 to 20.4 per cent. The mortality by consumption in Massachusetts has also been undergoing a steady diminution year by year—*pari passu* with the diminution of the proportion borne by the Irish population of the State. Thus, in 1855, the death-rate by consumption was 4.19 per 1,000; in 1865 it was 3.68; and in 1875 it was 3.47. Similar changes have taken place in Boston, whose population contains the largest proportion of Irish inhabitants existing in any city in the United States. In 1855 the population of Boston comprised 28.8 per cent. of Irish; the death-rate by phthisis stood at 4.58 per 1,000; of all the decedents by that disease, 50.7 per cent. were Irish. In 1870 the percentage of Irish inhabitants was 22.7; the phthisis-rate was 3.95 per 1,000; the percentage of Irish decedents was 40.2 per cent. In 1875 the proportion of Irish population had declined to 20.4 per cent.; the phthisis-rate was only 3.09 per 1,000; the proportion of Irish consumptives was 36.40 per cent. of all the persons so dying. The inference seems unavoidable that the gradual decrease of the mortality by phthisis in Massachusetts is due, in great measure, to the coincident diminution of the Irish ingredient of the population, and not, as has been supposed,[2] to greater intelligence of the people in the matter of self-preservation, or to increased skill on the part of physicians as regards the management of the disease, or to changes of climate resulting from the thinning of the forests.

Influence of sanitation upon mortality.—We are now led to inquire to what extent the mortality of mankind is subject to control by human agencies. Is it possible for us to resist successfully the inroads of disease and of death, to increase the duration of life—in other words, to diminish the death-rate; or is mortality regulated by inexorable laws, which defy and set at naught all our best-considered and most laborious attempts at sanitation? It would hardly seem necessary to discuss such a question, implying, as it does, a doubt of the usefulness and efficacy of all the precepts of public hygiene set forth in this volume. Yet, on the strength of the fact that death-rates are not unfrequently found to remain stationary in spite of the most elaborate and costly precautions, it has been questioned whether any good were really accomplished by the exertions of sanitary authorities. The death-rate of England, for instance, has for years stood at very nearly the same level, in spite of the unexampled extent to which all the resources of State medicine have there been developed.

[1] First Annual Report of the New York Board of Health, p. 245.

[2] Thirty-second Registration Report of Massachusetts, 1873, p. 77.

Should it be inferred that all the expenditure of intelligence, of labor, of money, all the great public works and administrative reforms effected by the sanitary authorities of that enlightened country have been in vain? The answer is that the changes in the character of the population have been such that the stationary death-rate itself is a subject of congratulation, and not of reproach, for sanitary science. We have seen how great an influence is exerted upon mortality by density of population. In England, as in all other civilized countries, there has been a constant increase of the proportion of urban population. "In the last twenty years," says Dr. Farr,[1] "the towns of England have increased from 580 to 938; their population from 9 to 14 millions; and the health of the whole population has remained stationary." The same tendency toward increasing concentration of the people in cities, with all its evil effects upon sanitary condition, is observed in other countries. In France, in 1846, the percentage of urban population was 24.4; in 1856 it was 27.3; in 1866 it was 30.4; and in 1872 it had reached 31.0.[2] In Massachusetts, towns with 10,000 and more inhabitants contained 6.8 per cent. of the whole population of the State in 1800; 22 per cent. in 1840; and 48.7 per cent. in 1870.[3]

To demonstrate the improvements in sanitary condition and in longevity brought about by the agency of man, to show how much mortality has been diminished and the duration of life increased, as civilization has advanced, and as the science and art of preventive medicine have been developed, would require a review of the history of sanitation from the time of the earliest records to the present day.[4] For such an historical survey space cannot here be afforded. We will, however, mention some of the results arrived at by Dr. Buchanan[5] in the course of an extensive and elaborate inquiry into the sanitary condition of English towns, as affected by sanitary improvements of various kinds.

The towns, whose condition was investigated by Dr. Buchanan, were twenty-five in number, containing together an aggregate population of 606,186 inhabitants. Their sanitary condition and their mortality-rates for many years previous to the improvements had been carefully ascertained. The sanitary operations effected were of various kinds, comprising: (1) Drainage works, affecting surface, subsoil, and houses; (2) improvements in water-supply; (3) measures for the removal of decomposing organic matters, and for preventing contamination of air and water thereby; (4) improved paving, scavenging, and public cleanliness; (5) amendment of lodging-houses, and repression of overcrowding. Several

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[1] Supplement to the Thirty-fourth Report of the Registrar-General, p. viii.

[2] M. Block: Loc. cit., p. 457.

[3] Essay on Political Economy of Health, E. Jarvis, M.D. Fifth Massachusetts State Board of Health Report, 1874, p. 367.

[4] See a paper on The Increase of Human Life, by Dr. E. Jarvis, read before the American Statistical Association, Boston, 1872. See also McCulloch's Account of the British Empire, London, 1854, Vol. II., Chapter VII.

[5] Report by Dr. Buchanan on the Results in England of Works and Regulations designed to promote the Public Health: Ninth Report of the Medical Officer of the Privy Council, London, 1867.

years having elapsed since the completion of the improvements, the mortality returns were compared with those relating to the years preceding. The following figures, borrowed from the much more extensive table contained in Dr. Buchanan's report, will suffice to give an idea of the nature and extent of the results found to have been accomplished :

Towns.	Death-rate before Construction of Works.	Death-rate after Construction of Works	Reduction of Typhoid Fever, per cent.	Reduction of Phthisis, per cent.
Banbury..........	23.4	20.5	48	41
Cardiff............	33.2	22.6	40	17
Croydon	23.7	18.6	63	17
Dover.............	22.6	20.9	36	20
Ely................	23.9	20.5	56	47
Leicester..........	26.4	25.2	48	32
Macclesfield	29.8	23.7	48	31
Merthyr...........	33.2	26.2	60	11
Newport..........	31.8	21.6	36	32
Rugby............	19.1	18.6	10	43
Salisbury..........	27.5	21.9	75	49
Warwick..........	22.7	21.0	52	19

In these twelve towns the mean death-rate was lowered from 25.6 to 21.7 per 1,000. The diseases in which the greatest reduction was effected were typhoid fever, phthisis, and diarrhœa. Of special influence exerted by sanitary works upon infants under one year of age, different from that exerted upon the total population, no evidence whatever was obtained.

The results in regard to phthisis were such as to afford a remarkable confirmation of the etiological law discovered in this country by Dr. H. I. Bowditch,[1] and first enunciated by him in 1862, in accordance with which dampness of soil is one of the chief causes of consumption. It was found by Dr. Buchanan that the dryness of soil, which had in most cases accompanied the laying of main sewers in the improved towns, had led to the diminution, more or less considerable, of phthisis.

In his comments upon Dr. Buchanan's remarkable report, Mr. Simon, after remarking upon the difficulties attending such an investigation, says:

[1] The "Law of Soil Moisture," as laid down by Dr. H. I. Bowditch, was stated in the form of the following two propositions : (1) A residence on or near a damp soil, whether that dampness be inherent in the soil itself, or caused by percolation from adjacent ponds, rivers, meadows, marshes, or springy soils, is one of the primal causes of consumption in Massachusetts—probably in New England, and possibly in other portions of the globe. (2) Consumption can be checked in its career, and possibly—nay probably—prevented in some instances by attention to this law. See a paper on the Topographical Distribution and Local Origin of Consumption in Massachusetts: Read before the Massachusetts Medical Society. May 28, 1862, by Henry I. Bowditch. See also Public Hygiene in America, H. I. Bowditch, Boston, 1877, p. 453.

"Meanwhile, however, the present records may fulfil very important provisional uses; not only to confute persons who have despaired, or affected to despair, of any great preventability of disease; but still more to justify in the public eye, and to encourage in some of the noblest of human labors, those who for long weary years have been spending their powers in this endeavor, and to whom it will be the best of rewards to see demonstration of the good they have wrought."

Longevity.

The first method that usually suggests itself for determining the average duration of life in any community consists in calculating the *mean age at death*, or average age of decedents, which is obtained from the records of mortality, by adding together the ages of all that die, and dividing the sum total of years by the number of deaths. The mean age at death, which is so readily calculated from the ages and number of the dying alone, is, however, a very fallacious indication of longevity, for the reason that it is subject to very great variations dependent upon the varying proportions of young and old lives in the populations among which the deaths occur. Two populations undergoing precisely the same mortality, of which one is stationary, the yearly births and deaths being equal and the other increasing, the yearly births more or less exceeding the yearly deaths, will yield very different mean ages at death. By the life-table of England a million annual births imply a million annual deaths; half of the persons live forty-five years, which is the probable lifetime; the mean age at death is 41 years (40.85). In reality, however, the population of England is not stationary, but is constantly increasing. During the seventeen years, 1838–'54, in addition to the 380,631 births to balance the 380,631 deaths, 191,068, making 571,699 children in all, were born annually and thrown into the population. Consequently, the mean age of all who had died in the seventeen years was 29.4 instead of 40.9—the reduction, 11.5 years, being the result of the introduction of an excess of young lives.[1]

An unimpeachable indication of longevity is afforded by the *expectation of life*, also called the mean lifetime, after lifetime, mean duration of life (*vie moyenne* of the French). This statistical expression is calculated from the data relating to population and deaths which enter into the composition of life-tables. It is obtained by adding together the number of years which the entire tabulated population live from any specified age, and dividing the resulting total "years of life" by the number living at the year of age for which the expectation of life is desired.[2]

The expectation of life, calculated for a series of ages, from birth up-

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[1] See the English Life-Table, London, 1864, pp. xxxv., xxxvi. Also, Fifth Report of the Registrar-General, 1843, p. 39.

[2] English Life-Table, p. xxxiii.; Fifth Report of Registrar-General, p. 24; Ninth United States Census: Vital Statistics, p. xv.

ward, represents the portion of future life which an individual at any age may reasonably expect to enjoy. Tables affording information of this character are, therefore, highly useful—in fact, indispensable, as guides, in all pecuniary transactions in which the value of life contingencies has to be taken into account, such as the insuring of lives and the sale of annuities. In the former class of operations, yearly premiums proportioned to the risks are paid by the insured person against a lump sum to be paid to his survivors by the office after his death; in the latter, a lump sum is paid at the outset by the annuitant, in return for which he receives yearly annuities so long as he lives. In both cases the chances of living are the basis upon which the terms of the bargain are established.

Formerly the chances of living at any age were deduced from mortality tables, these being the only available sources of information. Now, however, insurance offices have accumulated records of their own experience, from which trustworthy tables showing the expectation of life are constructed. These now serve as the basis for premiums. Such tables differ from ordinary tables in that they relate only to insured, and consequently "selected" lives, whereas the latter relate to the chances of life prevailing indiscriminately throughout an entire population. The figures expressing the expectation of life are therefore apt to be higher in tables based upon insurance experience, than in tables deduced from the general mortality of any community. We will now give a few examples of tables derived from both of the sources alluded to.

The following table shows the expectation of life prevailing in England and Wales, for both sexes, and for each sex. The expectations of life for both sexes, at the same ages, in Massachusetts and in Prussia, are also shown.

EXPECTATION OF LIFE, ACCORDING TO LIFE-TABLES.

AGES.	England and Wales, 1838–'54. Farr.			Massachusetts, part of, 1855. Elliott.[1]	Prussia, 1839–'41. Elliott.[1]	AGES.
	Males.	Females.	Persons.	Persons.	Persons.	
0	39.91	41.85	40.9	39.8	36.7	0
10	47.05	47.67	47.4	47.1	44.8	10
20	39.48	40.29	39.9	39.9	37.5	20
30	32.76	33.81	33.3	34.0	30.6	30
40	26.06	27.34	26.7	27.9	23.8	40
50	19.71	21.08	20.1	21.3	17.1	50
60	13.00	13.91	13.9	15.0	11.1	60
70	7.55	8.15	8.7	9.4	7.4	70
80	4.04	4.37	5.1	5.0	4.8	80
90	2.20	2.35	2.9	2.9	3.0	90
95	1.67	1.76	2.2	2.3	....	95

[1] From Ninth United States Census: Vital Statistics, p. xiii.

It would be highly interesting to compare the expectation of English lives with that of American lives, but the elements of a satisfactory comparison are lacking. For this reason the records of the experience of insurance companies in this country and in England are valuable sources of information. The following table shows the expectations of life at various ages, according to the experience of English life insurance conducted on a large scale through many years, and according to the experience of one of the largest and oldest companies in the United States. A separate column shows the Irish experience recorded in England :

EXPECTATION OF LIFE, ACCORDING TO EXPERIENCE OF LIFE INSURANCE OFFICES.

Ages.	English companies.			New York Mutual Life Insurance Company.[4] 1843–'74.	Ages.
	New Actuaries'.[1]	Combined Experience.[2]	Irish Experience.[3]		
10	50.29	48.36	.....	52.03	10
20	42.06	41.49	34.95	44.99	20
30	34.68	34.43	29.71	37.59	30
40	27.40	27.28	23.36	29.93	40
50	20.31	20.18	17.76	22.23	50
60	13.83	13.77	12.67	14.96	60
70	8.50	8.54	7.62	8.80	70
80	4.72	4.78	4.75	4.39	80
90	2.36	2.11	.....	1.87	90
95	93	1.28	.....	1.19	95

The figures contrasted in this table show some remarkable results. We see therein, in the first place, that the expectation of life in the United States, among selected lives, is somewhat higher than in England under apparently similar conditions, and therefore appears to indicate lower rates of mortality among the American than among the English population.[5]

[1] The New Actuaries' Table, combining the experience of twenty English offices, was prepared by a committee of the English Institute of Actuaries, and published in 1869.

[2] The "Combined Experience" Table, formed from the experience of seventeen English offices, by a committee of the English Institute of Actuaries, was published in 1843.

[3] From "A Series of Tables of Annuities and Assurances," Jenkin Jones, actuary, London, 1843, Table VIII.

[4] Mortuary Experience of the Mutual Life Insurance Company of New York, from 1843 to 1874, Vol. II., Table VII.

[5] The actuary of the New York Mutual Life Company, Mr. W. H. C. Bartlett, remarks in his report, that "the facts in this table indicate that the risks of this company have been carefully selected, and that the mortality of American lives, such as have been here insured, is lower than that in the English offices" (page 8). He adds :

The figures showing the expectation of life among Irish insured lives, on the other hand, indicate high rates of mortality. The actuary by whom they were tabulated says [1] that "from the Irish experience it appears that, of that class of assurances, at some of the younger ages, the expectation of life is as much as six years less than that obtained from the combined English town and country experience." These results are interesting, when considered in connection with what is known respecting the mortality prevailing among the foreign-born inhabitants of this country.

Morbility.

The liability to sickness prevailing in any community cannot be accurately ascertained or stated, owing to the very uncertain and limited character of the information on which our estimates must be based. No precise line of demarcation exists by which health can always be distinguished from disease, these two conditions being connected by a series of intermediate states, in which it is often impossible to determine where the one ceases and the other begins. Only certain kinds or degrees of sickness, severe enough to involve confinement to bed or house, or to incapacitate from labor, can be recognized with sufficient distinctness to admit of being recorded. The available data are therefore limited to the unequivocally disabling diseases. Moreover, such information as we possess in relation to this kind of sickness is derived from very limited sources. No complete and uniform system of registration of diseases has yet been devised by means of which the degree of prevalence of sickness can be determined; this branch of registration has been useful only as a means of promptly notifying sanitary authorities of the existence of infectious or preventable diseases. The data upon which estimates of liability to sickness are based have been obtained mainly, in England, among great assemblages of men employed in organized labor on a large scale [2] (government workmen, large

"The result of these comparisons leaves little doubt that the experience of this company has been more affected by selection than that of the English" (page 11).

A reviewer in the London Lancet says: "The most noteworthy fact in connection with the mortality experience of this office is that its rates of mortality, at nearly every age, are considerably lower than those in the English life-table; whereas, in most English offices, the experienced mortality exceeds the life-table rates. It has been sought to explain the high rate of mortality in English offices, by the assertion that among insured lives there is always a selection going on against the company, the effect of which is that all deteriorating lives remain, whereas the withdrawals consist entirely of the best lives. It is difficult to imagine why an American office should be free from the operation of this adverse selection, and therefore the low mortality experience of this Mutual Life office acquires additional interest, and appears to indicate a generally lower rate of mortality among the American than among the English population. This seems more probable than that the difference is due to a more careful and exclusive selection among those offered for insurance in the New York Mutual office than prevails in the majority of English offices. (Lancet, February 23, 1878, p. 281.)

[1] Jenkin Jones, loco citato, p. xvi.

[2] See McCulloch's Account of the British Empire, London, 1854, Vol. II., chapter vii.; Vital Statistics, by Dr. Wm. Farr, pp. 570–596.

manufacturing or industrial corporations, etc.), and among philanthropic or charitable associations,[1] having for their object to provide insurance against sickness (friendly societies, benefit societies, health insurance companies). From these sources records of disabling sickness are obtainable, from which approximative estimates can be made of the liability to sickness of this kind prevailing among individuals of the classes concerned, consisting of adult males of the laboring or poor classes. The statistical results arrived at in this way have always been too wanting in comprehensiveness and uniformity to admit of general application.

A few examples of data, selected from the very copious sources of information to which allusion has been made, will show the nature of the evidence upon which our knowledge of the amount of sickness prevailing is based.

The following table[2] shows the time lost by sickness and by accidental injury among the laborers in Portsmouth and Woolwich dockyards:

	Mean number of workmen.	Days lost by sickness.	Days lost by accidents.	Constantly sick, per cent.	Constantly suffering from accidents, per cent.	Constantly ill from both causes, per cent.
Portsmouth..	5,939	27,410	15,590	1.26	0.73	1.99
Woolwich....	2,243	10,593	8,594	1.29	1.05	2.34

The statistics collected in these dockyards (1830–1832) gave the following results: in each year one man in six was seriously hurt; two in five fell ill; each man on an average had, every two years, an attack of illness, either spontaneous or traumatic in origin, lasting, on an average, fourteen days. Of all the laborers employed in the government dockyards, two per cent. were constantly kept at home by sickness or injury of some kind, spontaneous disease not dependent upon injury constituting nearly two-thirds of the entire causes of disability.

The friendly or benefit societies undertake to insure members against sickness in consideration of periodical contributions to a common relief fund. The membership of these societies is limited to individuals of satisfactory health, habits, and morals. The diseases which entitle a member to relief from the fund, in return for his assessments, must be cases of "bedfast sickness" sufficiently severe to last more than a week, incapacitating from labor, but not permanent or incurable.

The mean proportions of such disabling sickness, occurring at differ-

[1] See Contributions to Vital Statistics from Data supplied by Friendly Societies: F. G. P. Neison; Journal of the Statistical Society, Vol. VIII., 1845, p. 290. See also Parliamentary Report on Sickness in the Friendly Societies, 1853.

[2] McCulloch's Account of the British Empire, Vol. II., p. 573.

ent groups of ages, among members of English and Scotch friendly societies, are given in the table[1] below, together with corresponding figures relating to the East India Company's laborers.

AVERAGE NUMBER CONSTANTLY SICK TO 100 LIVING AT EACH AGE.

Ages.	Friendly societies.				East India Company's laborers.
	Scotland (Highland Society).	England (Ansell).	Scotland (Neison).	England (Neison).	
20–30	1.14	1.54	1.65	1.69	1.62
30–40	1.32	1.83	1.66	1.91	2.06
40–50	1.97	2.56	2.44	2.89	2.69
50–60	3.60	4.32	5.17	5.21	6.58

The results exhibited in this table, derived from different sources, show a remarkable uniformity, which testifies to the accuracy of the records upon which they are based. All conditions being equal, the liability to sickness, the morbility, seems to be as uniform as the mortality. The amount of sickness, measured by the proportion of sick-time to life-time, increases with age. Thus, the experience of the Highland Society showed that between the ages of 20 and 30 years, out of 100 units of life-time (days, weeks, or years) 1.14 units were lost by disabling sickness; from 50 to 60 the loss was 3.60 per cent.; from 60 to 70 it was 10.80; from 70 to 90 it reached 31.70. In the English societies, the percentage of sick-time to life-time between the ages of 20 and 30 was 1.54; from 80 to 90 it amounted to 40.0; and from 90 to 93, to 67.0, over two-thirds of the time at that age being occupied by disabling sickness.

From such records of sick-time, obtained in England from the various sources above mentioned, it has been estimated that, in that country, to one annual death in a body of men, two men are on an average constantly suffering from sickness of some severity. To every death there are two years of severe illness. In the police and in some friendly societies, the constantly sick to every death that occurs are 2.8; in the army at home the sick amount to 4.2, the difference being due to the prevalence of venereal disease. Applying these ratios, Dr. Farr estimates the amount of sickness that prevailed in England in 1871 to have been as follows: "The deaths in England in the year 1871 were 514,879, implying 1,029,758 persons constantly sick from diseases of some severity; that is equal to a number sufficient to fill 10,298 hospitals, each containing 100 beds always occupied. And it may be assumed that the numbers are

[1] McCulloch's Account of the British Empire, London, 1854. Vol. II., p. 582. See also page 571.

sustained by an annual influx of 12,237,096 patients, ill a month on an average, of whom 11,842,217 recover, 514,879 die."[1]

By applying the results of English experience to the population of Massachusetts, Dr. Edward Jarvis[2] estimates that in that State, in 1870, there was among the people of the working productive ages alone a total loss of 24,553 years, caused by sickness or disability.

The frequency of occurrence of certain diseases can be approximately estimated from the deaths which they occasion in a community.[3] If a disease attacks people but once, and if the fatality attending its attacks has been determined by observation carried out on a sufficiently large scale, as in hospitals, then it is possible, from the registered deaths caused by that disease, to estimate roughly the number of cases that have probably occurred. Such is the case with several of the acute infectious diseases, which, as a rule, occur but once in a lifetime. Thus, with regard to scarlet fever, it was shown by the Registrar-General of England[4] that in 1876 there were in London 2,297 deaths by that disease. The cases treated in the hospitals during the same year amounted to 1,355, among which the deaths were a little over 10 per cent. From these data, it was calculated that at least 22,885 cases of scarlet fever had occurred in London during the year. This estimate probably fell short of the real number of attacks, as it is suspected that the mortality of the disease is greater in hospital than it is out of hospital. Nearly 70 per cent. of the fatal cases occurred among children under five years of age, and it was, therefore, estimated that at least 15,000 out of the 453,171 children living at that age in London, or about one in 30, suffered from scarlet fever during the year. Similar calculations have been made with regard to other acute infectious diseases, such as small-pox, cholera, enteric fever, etc.

The diseases of which the degree of prevalence can be roughly estimated by this method are not numerous. There are many diseases to the frequency of which the deaths give no clue, either because the diseases in question are rarely or never fatal (*e. g.*, mumps, varicella, tonsillitis, gonorrhœa), or because they are liable to recur several times in the same individual (*e. g.*, rheumatic fever, intermittent fever, epilepsy, asthma). On the other hand, with regard to those diseases which invariably prove fatal (such as hydrophobia, cancer, phthisis), the deaths recorded imply necessarily an equal number of attacks.

The foregoing statements show that the data at hand, from which the general prevalence of disease may be estimated or measured, are very incomplete. It is to be hoped that the plans of registration of diseases now under trial in several communities may soon afford more comprehensive and accurate information than we at present possess.

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[1] Supplement to the Thirty-fifth Report of the Registrar-General, p. lxxviii.

[2] Paper on the Political Economy of Health: Fifth Report of the Massachusetts Board of Health, Boston, 1874, p. 345.

[3] See the Supplement to the Thirty-fifth Report of the Registrar-General of England, p. xxxvi.

[4] The Lancet: February 17, 1877, p. 250.

ADULTERATION OF FOOD.

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ADULTERATION OF FOOD.

No branch of sanitary science has proved so troublesome to deal with as that relating to food and its adulterations. Sumptuary legislation is always unpopular, and all legislators who have attempted to legislate upon this subject of food have found themselves compelled to legislate in such a manner that the execution of the laws interfered more or less with the great natural laws of supply and demand. For a large portion of the adulteration practised is but an attempt to supply the demand in seasons of scarcity, by the substitution of cheaper articles for the genuine high-priced and scarce article known to commerce.

The statute-books of all nations abound in laws upon this subject, which are practically dead letters.

This arises from two causes: the first is ignorant, indiscriminate legislation; a law which condemns equally flour or rape-seed and chromate of lead in mustard is soon looked upon with contempt. The second cause is too conservative or too definite legislation. There are many laws which condemn specifically certain adulterations. The adulterator carefully avoids these substances, and substitutes for them others, perhaps not less dangerous, and continues in his way.

Another objection to this specific legislation is the fact that, when an adulteration is thoroughly exposed, it becomes practically dead, since, if it is known to the whole of the trade, it ceases to be profitable. For the adulterator's only hope of profit is in the secrecy with which he carries on his nefarious trade. So long as he keeps his invention concealed, it is profitable; as soon as it is discovered, competitors step in, adopt the same expedient, and soon there is no more profit on the sophisticated article than on the genuine.

But all prohibitory legislation necessarily follows the act which it is intended to prevent, and therefore specific laws against any particular adulteration have but little force, since they come too late to be of any benefit; by the time the law is upon the statute-book the old adulteration has been forgotten, and a new one has taken its place; or, since legislators are proverbially kind to the erring, some convenient loop-hole, such as the "prejudice to buyer" section of the English law, is left in the law through which the offender may escape, and by the time this is mended another one is discovered.

England has legislated more on this subject, during the past hundred years, than any other country, and a careful examination of her laws will serve fully to illustrate what I have said.

A law upon this subject must be simple, easily understood, and general in its application, and it should not attempt to control all commercial frauds, but only such as are directly detrimental to health.

Under the action of laws of this kind, there has gradually grown up a class of experts, who have made a special study of this subject, and there are many valuable monographs upon special branches of adulteration, and a few general works upon the subject.

A general account of the apparatus and appliances that have been found useful in this branch of research will be given, and afterward some of the adulterations of the more common articles of food, with the methods for detecting the same, will be described.

Knowledge required.—The food analyst, who must be a chemist, should be furnished with a well-fitted laboratory, since he will find it necessary to call to his aid a thorough knowledge of chemistry, and he must be a man of good judgment, who is not easily led astray by public clamor, since, by making a few blunders, he may do a great amount of harm to the honest dealer without benefiting the public. Besides being a chemist, he must be well acquainted with the practical use of the microscope, since much of his work has to be done with this instrument.

Apparatus required.—The following list of apparatus is almost indispensable. The outfit, at present prices, will cost from six to seven hundred dollars, if bought in this country. From one-quarter to one-third of the price may be saved by importing directly from England or Germany.

Microscope.—A good instrument provided with two eye-pieces and two objectives (a one-inch and a quarter-inch). These will give a range of magnifying power of from 50 to 300 diameters, which will be found to be sufficient for all ordinary requirements. The instrument should have the "society screw" for the objectives, so that no trouble will be found at any time in increasing their number.

It should also be furnished with a polarizer. The ordinary second-class objectives of the best makers will be found to be good enough for most purposes. As a rule, they are better at present than the best that could be obtained twenty years ago.

The ordinary student's stand is all that is needed. The instrument complete may be bought for about eighty or ninety dollars.

Balance.—This should be capable of carrying 200 grms. in each pan, and show with this weight a variation of half a milligrm. or less. Such a balance and weights will cost about one hundred dollars.

In addition to this balance, a prescription balance, with the beam under the pans, will be found very convenient. Such a balance costs about twenty dollars.

Platinum.—Four platinum dishes. These should be 6 ctm. in diameter and 15 mm. deep, and should weigh about 20 grms. each. They *must* have flat bottoms.

One platinum crucible, 4 ctm. deep and 25 mm. wide at top, with a lid in the form of a capsule.

One platinum dish holding about 120 c.c. of water. This should weigh about 50 grms. This is also best made with a bottom almost perfectly flat. Flat-bottomed dishes have a great advantage over the hemispherical in rapid evaporation. With two dishes of equal diameter at the top, one being hemispherical and the other flat, 5 c.c. of milk will evaporate to dryness in about half the time in the flat dish that it takes in the hemispherical dish, and the after-manipulation is made more convenient.

The small dishes will be found much more convenient than crucibles for the ignition of organic substances.

It is well to have a flat piece of platinum about seven ctm. in diameter to serve as a cover for these dishes when they are used to ignite substances that are liable to decrepitate when heated. When the decrepitation has ceased, the lid is removed, and, after igniting over a burner, the adhering ash is added to the contents of the dish.

Porcelain crucibles.—A dozen each of Nos. 0 and 1 will be found useful.

Porcelain dishes.—Two or three nests of half a dozen each, capable of holding from half a litre down. These are also best of the flat form.

Beakers.—It is difficult to get too many of these. Half a dozen nests of Griffin's make, of the wide form with lips, will not be found too many.

Watch-glasses.—A dozen three-inch and a dozen four-inch watch-glasses, to be used as covers for beakers and for evaporating small quantities of liquid, and for making preliminary observations in general.

Test-tubes.—A dozen each of three different lengths (4, 5, and 6 in.).

Gas-lamps.—One blast lamp and bellows for intense heat. The form made by the Buffalo (N. Y.) Dental Manufacturing Co. is the most convenient I have met with.

Two or three ordinary Bunsen burners, and at least two gas-lamps (the flat form, made by Burnham, corner Tenth and Sansom Streets, Philadelphia), are extremely convenient.

A small muffle-furnace.—The gas muffle-furnace, known as Griffin's miniature, will be found to be a great convenience. The muffle in this can be maintained for hours at a bright red heat, without any attention, with the consumption of about twenty feet of gas per hour. Cream of tartar, bread and similar substances are readily burned in this, without loss, to a white ash. The heat can be so nicely regulated as to leave the ash unmelted and of the form of the article burned. This furnace costs, all complete, about twenty dollars.

Water-bath.—The ordinary water-baths sold by dealers will be found to be of but little use, as they require constant attention, and hold but one dish at a time.

A much more convenient form is one made of a copper dish, which is nearly hemispherical, and measures about 35 ctm. in diameter. This is provided with a cover, and with three legs of such a length that a Bunsen burner stands under it to good advantage.

The cover is pierced with five holes—a small one in the centre and four around it—the outer ones being made as large as they conveniently can be. The centre hole, which should be of such a size as to support the platinum crucible, is provided with a copper cover; the outer ones are provided with the ordinary water-bath rings, a single ring being provided for each hole. The opening in these rings is of such a size that the small platinum dishes are just supported. The rings are also provided with covers, so that one or all of the holes can be used, as may be found necessary.

Air-bath.—This is best made of tin, with double sides and a heavy iron bottom. The common tin ovens sold with gas-stoves answer very well when slightly modified. The one which I have used for years has double sides and top, the bottom being made of an iron plate, which is heated by a single Bunsen burner. It is provided with a Bunsen gas-regulator, and a temperature of 100° C. can be maintained for hours with but little variation.

Pipettes.—The set should comprise five: one of a capacity of 100 c.c., one of 50 c.c., one of 25 c.c., one of 10 c.c., and one of 5 c.c.; also one graduated the same as a burette, with a capacity of from 0 to 10 c.c. by tenths.

Burettes.—Two holding 100 c.c. each, and one 50 c.c., with glass stop-cock.

Flasks.—Two or three of 100 c.c., one or two of 500 c.c., and one of 1,000 c.c. These should be graduated with a ring around the neck.

Measuring jars.—Half a dozen jars about 25 ctm. high, graduated into 100 c.c. These will be found useful as creamometers and also in ammonia tests.

A lamp stand, half a dozen 3-inch funnels, a supply of filter paper, and a stock of sample bottles, will about finish the supply of apparatus.

Reagents.—The ordinary reagents, mentioned in the text-books on qualitative and quantitative analysis, will be found to be full enough for any case that is likely to arise.

Obtaining samples.—This is frequently a matter of difficulty, since the courts are apt to look with disfavor on the purchase of samples for the purpose of testing their purity with a view to criminal prosecutions, very many of which, in cases of this nature, have arisen more out of malice or mistaken zeal on the part of the complainants than from any desire to benefit the public. If possible, it is best to have the samples come through a third party, who can show that he was injured in some way by their sale. In the case of milk, some of the States have prescribed methods of procedure, and appointed officers whose duty it is to inspect the milk and listen to complaints. It is very difficult, however, to get any one to come forward and institute a complaint against a dealer. This arises partly from the fact that a large portion of the community is under obligations to the store-keepers, and is thus in their power, and partly from the dislike to injure a neighbor. If, however, complaint has been made to the proper officer, that a certain party is selling an adulter-

ated article, there is then no objection to the purchase of a sufficient quantity of the suspected article for purposes of analysis. This sample, however, should be obtained in such a manner as will fix the fact in the mind of the seller. It is generally sufficient to ask that a bill be given of the same. This serves two purposes: it establishes the fact of the sale, and—so far as it is designated—the character of the article sold. In a recent case of the sale of adulterated olive-oil, it was claimed that the article was not sold as pure olive-oil; but the bill of sale was produced in court, and, as it called for "olive-oil," the judge very properly ruled that olive-oil meant olive-oil, and not a mixture of cotton-seed and olive-oil.

Treatment of sample.—After the sample has been received, if the article is of such a nature that it can be preserved, it should be divided into two portions; one of these should be placed in a glass bottle and sealed, in order that it may be shown in court if the case happens to come up. The other portion is for use in the analysis. If the analyst is not perfectly familiar with the article in question, he should procure several samples known to be genuine, and compare these at every step of the analysis with the suspected article. He should also consult whatever books he can obtain in regard to the article in question, bearing in mind, however, that books cannot be used in court, except on cross-examination, and that one case cited from personal experience is worth twenty from the books.

Interpretation of results of analysis.—This is often extremely difficult, and requires not only a full knowledge of the value of the determinations made, but also of the state of the market, the processes used in the manufacture of the article in question, and a careful discrimination between accidental impurities and foreign substances that cannot be accounted for in any manner except that they must have been intentionally added.

It is well also for the analyst to inquire whether the adulteration is injurious to health, for the addition to food of an article injurious to health is a much graver offence than the ordinary fraudulent adulterations, such as are commonly found in commerce.

Above all, the analyst should never allow his zeal to run away with his discretion. His position is a responsible one, and it is his duty to avoid giving needless alarm, and he should, above all things, be careful not to proceed in a case until his evidence is very strong, for one case lost by careless management will do him and the cause more harm than ten cases gained will benefit them.

Classification of adulterations.—Adulterations of food may conveniently be divided into three classes: deleterious, fraudulent, and accidental.

Deleterious adulterations are such as are directly injurious to health. *Examples:* copper in pickles, red lead in Cayenne pepper, arsenical colors in candy, and water in milk—the latter by diminishing the food value of the milk, and so starving the children who are fed upon it. In this class must also be placed all sophistications of drugs and medicines, since the physician depends greatly upon the purity of these in regulat-

ing the size of the dose : if of inferior strength, they do not produce the desired effect, and thus become negatively injurious.

It is with this class of adulterations that the health officer is particularly concerned, and in endeavoring to frame laws against adulteration, particular attention should be directed to this division in order that it may be comprehensively defined. A case was recently lost in Massachusetts because it could not be proved that candy was an article of food in the ordinary acceptation of the term, and, although it was shown that it contained chromate of lead, the defendant was allowed to escape.

Much trouble in securing convictions for adulteration has arisen from the confusion existing in regard to the nature of the adulteration practised; many persons putting all adulterations without exception into this class. When asked in court to show how the adulteration was injurious to health, they have been unable to prove such injury, and the case has been lost.

Fraudulent adulterations.—These are such as are in no way injurious to health, but which are a fraud upon the pocket. These adulterations are by far the most common. Many of them have been sanctioned by long usage, and it is generally plead in extenuation of the whole class that no one is harmed by them, since the buyer, as a general rule, knows what he is getting. To this class belong such articles as package-coffee, which is generally a compound which contains no coffee ; salad-oil, which is frequently free from olive-oil, consisting mainly of cotton-seed oil ; mustard diluted with flour and colored with turmeric ; the mixture of inferior grades of goods with higher grades of the same material, the mixture being represented as pure and of full strength ; the mixture of corn-syrup or glucose with cane-syrup, the mixture being sold as pure cane-syrup ; the sale of oleomargarine or suet butter as genuine butter ; and the adulteration of spices with ship-bread.

These were all frauds in their inception, but, sanctioned by usage, they have become difficult to deal with. The health officer may and should expose them so far as he can, but he will find that he can do but little with them in the courts, the law holding that when the nature of the article is well known to both buyer and seller no fraud is committed.

The third class of adulterations consists of such substances as are accidently present in articles of food, *i. e.*, which have not been intentionally added, but are either present because natural to the article or because they have become incorporated in it during the process of manufacture.

This class of substances frequently causes considerable trouble to the health officer, and their presence requires him to possess a thorough knowledge of the process of production of the article in order that he may decide whether they have been intentionally added or are merely present through carelessness, or as a necessary consequence of some manipulation through which the article has passed in preparing it for use.

In case these accidental impurities are of such a nature as to be injurious to health, the article should at once be condemned, and means taken to prevent its doing any harm; though in this case it would hardly be just

to hold the vendor liable to a further degree than is involved in the loss of his property. To this class belongs the grit occasionally found in flour ground with recently dressed mill-stones; fragments of lead are also occasionally found in flour from the lead used in repairing the mill-stones. In the same category may be placed the sand found in raw sugars and the dirt and sand occasionally found in milk. A case recently occurred in this vicinity in which the cows had been bedded with dry sand. During the milking some of the sand dropped into the milk, and occasioned considerable annoyance, as it was found almost impossible to strain it out, and the milkman's business suffered in consequence.

Of the same nature is the dust found in the so-called overland teas. This dust arises from the constant jarring to which the tea is subjected during its long railway ride from San Francisco to the eastern ports. The tea is pure, but the presence of the dust has more than once served to condemn a fair quality of tea.

Another instance of the same kind was recently observed. In examining a number of samples of Cayenne pepper, the ash was found to be red, and one or two per cent. too high; and it was suspected that the pepper was colored with oxide of iron. On examination, however, it was found that the unground pods in some cases gave the same color and amount of ash, and that the oxide of iron was probably derived from adhering dirt of a ferruginous character. A small amount of tartrate of calcium in cream of tartar is another instance of the same kind.

Hassall, in his work on adulterations of food, gives a long list of articles found by himself and others in food. Some of these are hardly likely to occur at the present time; others seem to have been copied from one book to another, without comment or inquiry as to the probability of their occurrence. A table similar to this, but with the classification modified as above, is given below.

ARTICLES LIABLE TO BE ADULTERATED.

ARTICLES.	Deleterious adulteration.	Fraudulent adulteration.	Accidental adulteration.
Arrowroot.....	....	Other starches which are substituted, in whole or in part, for the genuine article.	
Brandy.......	....	Water, burnt sugar.	
Bread.........	Alum, sulphate of copper.	Flours other than wheat, inferior flour, potatoes.	Ashes from oven, grit from mill-stones.
Butter........	Copper..........	Water, other fats, excess of salts, starch.	Curd.
Canned vegetables and meat.	Salts of copper, lead.	Excess of water................	Meat damaged in the process of canning.
Cheese........	Salts of mercury in the rind.	Oleomargarine.	

ARTICLES LIABLE TO BE ADULTERATED (*Continued*).

ARTICLES.	Deleterious adulteration.	Fraudulent adulteration.	Accidental adulteration.
Candy and Confectionery.	Poisonous colors. artificial essences.	Grape-sugar..................	Flour.
Coffee........	....	Chiccory, peas, rye. beans, acorns, chefus-nuts, almond or other nut-shells, burnt sugar, lower-grade coffees.	
Cocoa and Chocolate.	Oxide of Iron and other coloring matters.	Animal fats, starch, flour, and sugar.	
Cayenne pepper.	Red lead.........	Ground rice, flour, salt and ship-bread, indian-meal.	Oxide of iron.
Flour.........	Alum......	Ground rice..................	Grit and sand.
Ginger.......	....	Turmeric, Cayenne pepper, mustard, inferior varieties of ginger.	
Gin	Alum salt, spirits of turpentine.	Water, sugar.	
Honey.	....	Glucose, cane-sugar...........	Pollen of various plants, insects.
Isinglass	....	Gelatine.	
Lard.........	Caustic lime, alum	Starch, stearine, salt.	
Mustard......	Chromate of lead, sulphate of lime.	Yellow lakes. flour, turmeric, Cayenne pepper.	
Milk...	Water...........	Burnt sugar, annotto..........	Sand, dirt.
Meat.........	Infested with parasites.	....	Tainted.
Horse-radish..	....	Turnip.	
Fruit jellies...	Aniline colors, artificial essences.	Gelatine. apple jelly.	
Oatmeal	....	....	Old and wormy.
Pickles........	Salts of copper, alum.		
Preserves......	Aniline colors	Apples, pumpkins. molasses.	
Pepper........	....	Flour, ship-bread, mustard, linseed-meal.	Sand.
Sago..........	....	Potato-starch.	
Rum..........	Cayenne pepper, artificial essences.	Water.......................	Burnt sugar.
Sugar	Salts of tin and lead, gypsum.	Rice-flour....................	Sand and dirt, insects dead and alive.
Spices........	....	Flour, starches.	
Cloves........	....	Arrowroot.	
Cinnamon.....	....	Spent bark.	
Pimento	....	Ship-bread.	
Tea....... ...	....	Foreign leaves, spent tea, plumbago, gum, indigo, Prussian blue. China clay, soap-stone, gypsum.	Ferruginous earth.
Vinegar.......	Sulphuric, hydrochloric, and pyroligneous acids.	Burnt sugar, water.	
Wine.........	Aniline colors, crude brandy	Water........................	Sulphate of potassa.

The above list is a formidable one; but, fortunately, the majority of articles sold in our markets are not adulterated with any injurious substances, and, in giving this list, it is not to be understood that these adulterations are frequent or even common. Many of them have, however, been met with recently, and the health officer would do well to be on his guard against the entire list.

Methods of Detecting Adulterations in Special Cases.

Arrowroot.—The only substances which are likely to be added to this as adulterations are "terra alba," which may be gypsum or China clay, and other starches.

The former may be detected by igniting five grammes of the suspected arrowroot, and weighing the residue. In a pure sample this should not exceed two or three parts in one thousand; if the residue is much larger than this, the arrowroot should be examined by the usual tests for gypsum and silicate of alumina. Arrowroot should not contain an excess of moisture. Other starches are detected by the microscope, a pure arrowroot being used for comparison. The most common adulterant is potato-starch.

Brandy.—This, when genuine, is the alcohol distilled from wine. As sold, however, it is rarely genuine. When made from the grape, it is made from the fermented husks, or marc, left after the wine is pressed out. A large portion of that in the market is made from so-called neutral spirits, which are merely alcohol which has been rectified by passing over wood charcoal. These neutral spirits are colored with burnt sugar, or "French color," and flavored with oil of cognac; a little catechu is then added, so as to imitate the taste of the wood, and, finally, a little simple syrup, so as to take off the rough edge and impart a smooth taste. In this country the spirit used is generally free from any objectionable ingredients. The foreign article, made from potato-whiskey, is more objectionable. No proof has been advanced, however, that these imitation brandies are any more deleterious than the genuine article. The adulterations are so close imitations of the extracts found in the true article, that it is extremely difficult to detect them, and all that can be done is to see that the article is free from excess of fusel-oil. The most ready test for this is the simple expedient of rubbing a little on the hand and observing whether any odor remains after the main part of the alcohol has evaporated. Good brandy should evaporate completely and leave no disagreeable odor on the hand.

Bread.—The chief troubles that are met with in regard to bread are, first, *light weight.* Following the English law, many of the States have decreed that the loaf of bread shall weigh a certain number of ounces; this is generally thirty-two. As a matter of fact, it is rarely found that bread holds out in weight. Some samples weighed in Boston, a few years ago, varied from 19 to 30 ounces. The price varied inversely as the weight, the 30-ounce loaf being sold for 8 cents, and the 19-ounce for 10 cents.

The bread sold in the poorer class of shops is apt to be dark in color, sour, and consequently heavy.

The common adulteration is by means of potatoes. When flour is high, and potatoes low, the bakers use potato-yeast to a considerable extent. There is nothing injurious in this use of potatoes, except that the bread is thus enabled to hold more moisture, and the consumer buys a little more water.

The controversy on the use of alum in bread is very old, and still continues in England. If alum is used in this country, it must be but sparingly. Research recently undertaken to find this ingredient was unsuccessful, though some of the bread would have been much improved by its use. The method of procedure for its detection, which has been found to be the best, is the following: Burn 100 grms. of the bread to ash. If this is done in a muffle, the ash may be reduced to whiteness; if over a lamp, some of the carbon will remain unconsumed. Treat this ash, which may vary from one-half to one and a half per cent., with strong hydrochloric acid; evaporate to dryness, to remove any silica that may be present; add a drop or two of strong hydrochloric acid and some boiling water; then filter; add to the filtrate a few drops of phosphate of soda, then ammonia in excess. The precipitate, which always forms, consists of phosphates of lime, magnesia, iron, and alumina. The two last are insoluble in boiling acetic acid. An excess of acetic acid should therefore be added, the liquid brought to a boil, and then filtered; the precipitate should then be ignited and weighed. Bread free from alum gives a precipitate of from .005 to .013 per cent. The larger amount is therefore to be subtracted from the amount of phosphates found, and the remainder multiplied by 3.733 gives the per cent. of ammonia alum in the bread; or, if potash-alum was used, then the factor should be 4.481.

Example: A certain bread gave .120 per cent. of phosphate of alumina.

$.120 - .013 = .107$ per cent. of phosphate of alumina.

$.107 \times 3{,}733 = .399$ per cent. of alum used, or a two-pound loaf would contain 54.86 grains of alum.

Some of the fancy crackers and ginger-snaps found in the market are said to contain considerable quantities of alum.

If the ash of bread or crackers rises above two per cent., it should be examined for mineral impurities.

Butter.—In this country this article has until recently been free from any adulterations, though occasionally a sample is met with containing starch. The commonest impurity is an excess of *water.* Good butter, when freshly cut, should not show any cavities containing discolored water. *Curd* or *butter-milk* may form one of the impurities of butter. This arises from imperfect working, and may be detected by examination with the microscope, or by melting the butter in a test-tube over a little water, when the milk and curd will separate from the fat and form a layer between the water and the fat. The amount of water may be determined by drying about three or four grammes of the butter over the water-bath

for some hours. The amount of curd may be ascertained by dissolving out the fat with ether and weighing the residue on a dried filter. This is ignited, and the amount of ash determined and subtracted from the total weight of residue from ether. This gives the amount of curd.

The amount of water in good butter should not exceed 12 per cent., the amount of salt 6 per cent., and the amount of curd 1 or 2 per cent. The residue from ether, if large, should be examined with the microscope for starch.

The presence of fats other than butter-fat is sometimes suspected, but no very satisfactory tests have yet been found for the same. Most of the tests given in the books proceed on the assumption that some special fat is used. The closest imitation to butter yet made is undoubtedly the oleomargarine of M. Mégé. This, when properly made, agrees with butter in its melting point. It is a little deficient in flavor, but not enough so to cause any remark. If carelessly made, it may contain traces of membrane, and may also show crystals of the stearates. But common butter frequently does the same. The most satisfactory test proposed so far is the determination of the amount of volatile acids contained in the butter-fat. For this purpose three grammes of the pure fat are saponified with a concentrated solution of potash. A clear soap is obtained in this way, which is decomposed with dilute hydrochloric acid; the temperature is raised above the fusing points of the acids; they are then thrown on a wet filter, washed with boiling water, and dried at 100° C. Butter gives about 88 per cent. of insoluble fatty acids, while other fats give about 95.5 per cent. Care must be taken, in washing the fatty acids, that it is done thoroughly, or else the results will lead to erroneous conclusions. Copper is occasionally present in samples of high-colored butter. It comes from the annotto which is used to color the butter, the annotto of commerce being frequently adulterated with sulphate of copper.

Canned vegetables and meats.—Frequent cases have been reported of late years of sickness arising from the use of canned meats. The cause seems mainly to have been improper methods of canning, or the use of meat that was tainted before being canned. Unfortunately we can do nothing in such cases by an inspection of the meat, for it generally appears to be all right.

In buying meats and vegetables—if care is taken in their selection, all cans being avoided which are not concave in the heads,—but little risk is run.

An examination of the outside of the can is the only guide we can have in this class of articles. The heads should be slightly concave. This shows that they were hot when sealed. If the heads are convex, it shows that decomposition has commenced in the can.

Sometimes, through careless soldering or the use of terne plate in making the cans, the articles preserved become contaminated with lead. As this, at the most, only exists in very small quantities, its detection is often a matter of difficulty. The best method of proceeding is to destroy the organic matter either with aqua regia or chlorhydric acid and chlorate

of potassium; then pass hydrogen sulphide through the dilute solution, filter and examine the precipitate in the usual manner for tin and lead.

Copper is also occasionally found in these goods; it comes from the copper vessels used in their preparation. This may be detected by the same means that are used in the detection of lead and tin. Copper is to be particularly looked for in canned vegetables and pickles, which were formerly very generally colored with salts of this metal. Another fraud practised in these goods is dilution with water or with syrup, the can having comparatively little solid matter in it. There has also been frequent complaint of light weight and small-sized cans.

Cheese.—Cases frequently occur in which cheese has undergone a peculiar fermentation, which renders it poisonous. Whole families have been seized with violent pains and vomiting after eating such cheese. This peculiar condition seems, however, to be of rare occurrence.

The rind of cheese is frequently washed with arsenical or mercurial washes to protect it from flies and other insects. It should therefore be examined separately from the rest of the cheese.

All cheese is artificially colored. This is generally done with annotto, and can hardly be called an adulteration.

Recently in this country "oleomargarine" is said to be substituted, to some extent, for the butter-fat which should be present. The method of working is to allow the milk to stand for twelve hours, and skim off the cream which is used in making butter. An equivalent portion of "oleomargarine," or of pure tasteless tallow-oil, is then added, and the cheese-making proceeded with in the usual way. The detection of this fraud is extremely difficult, if not impossible.

The analysis of cheese is made by taking two or three grammes cut into thin slices, drying it on the water-bath until it ceases to lose weight, then boiling it with benzine until the fat is extracted, and weighing the residue. The residue is ignited and the ash determined.

The composition of good American cheese, according to Blyth, is about as follows:

Water	22.59 to 31.80.
Fat	35.41 to 28.70.
Caseine	37.20 to 36.00.
Ash	4.80 to 3.50.

Skimmed-milk cheese will show much less fat and a larger proportion of caseine. Sage cheese is colored with chlorophyl and flavored with sage. It is customary to color only a portion of the curd, and then to mix this through the mass so as to give it a handsome mottled appearance. This cannot be regarded as an adulteration, as it comes under the head of those harmless operations which are done to please the eye or suit the taste of the consumer.

Candy and confectionery.—No article of food is so liable to be injuriously adulterated as candy and all kinds of confectionery. Even the perfectly white candy, which is free from injurious coloring matters, is frequently flavored with fusel-oil (essence of banana), oil of bitter almonds, or essence de mirabane (nitro-benzole), prussic acid in various forms known as almond flavor, and various other essences and extracts which are poisonous in their nature, and which are used in large excess by the makers in order to give a strong flavor to the article. Various coloring matters of a poisonous nature are used in the colored candies frequently to be found in the shops. A long list of such articles may be found in Hassall's treatise on Foods, or in an article published in the proceedings of the American Pharmaceutical Association for 1878. The vegetable colors can frequently be identified by dyeing pieces of mordanted cloth with them in a bath slightly acidulated with acetic acid. The aniline colors are easily identified by dyeing unmordanted wool in a neutral or slightly acid bath. Mineral colors must be sought for by the usual methods of qualitative analysis. For identification of coloring matters, Bolley's Manual may be studied with advantage.

Glucose is probably present to a greater or less extent in most candy, but frequently the candy is almost entirely composed of it. Such candy should be examined for free sulphuric acid and for excess of lime or sulphate of lime, since the glucoses of the market generally contain an excess of these bodies. The glucose itself is harmless; it is only its impurities that are to be feared. "Terra alba," which may be either gypsum or China clay, is frequently found in certain kinds of cheap candy, such as conversation lozenges. They are to be sought for in such candies as have a very white opaque appearance. Flour is sometimes classed as an adulterant. It is very apt to be present, as it is used for various purposes in the manufacture of candy. It is harmless, and less injurious than the real article. Its use, even in excessive quantities, can only be condemned on the ground that it is a fraud, so far as it is used to make weight. The frosting on cakes, being of the same nature as confectionery, is subject to the same adulterations and frauds.

Very frequently papers colored with Paris green, or with the aceto-arsenite of copper, have been used as a covering for rolls of lozenges, and such papers are almost universally used to make the ornamental leaves with which cakes are ornamented. Such a practice cannot be too strongly condemned.

Coffee.—This article is rarely, if ever, injuriously adulterated. The fraudulent adulterations, however, are numerous. The sophistications commence with the whole berry, which is polished and variously manipulated, so as to deceive the consumer as to quality. The berry itself has been imitated, according to some writers, though this story seems about on a par with wooden hams and nutmegs. It is sometimes weighted with water after roasting, by subjecting it to a current of steam while still warm.

It may be safely said that scarcely a brand of the so-called package-coffees contains any coffee.

Essence of coffee consists mainly of burnt molasses. Package-coffees are largely composed of peas, chiccory, and rye roasted and ground. A small nut, called chefus-nut, is occasionally found in the market, and is used for the same purpose. Almond-shells, treated with molasses and then roasted, make a fair imitation.

The best method of detecting these various articles is to become thoroughly familiar with the appearance of ground coffee under the microscope, low powers being used, such as two- and three- inch objectives, and then to compare the suspected articles with the genuine.

Throwing the suspected sample on cold water and stirring it around so as to wet each particle, will frequently serve to separate the adulteration. Pure coffee swims much longer than any of the ordinary adulterations, and it colors the water but slowly. Chiccory sinks and colors the water rapidly ; peas sink and only color it slightly ; rye colors rather more than coffee, and sinks rather more quickly. Chiccory is used very largely by hotels and restaurants to give the dark color to the infusion, which is thought by many to be an indication of strength. The grains of ground coffee are hard and crumble between the teeth ; ground chiccory is softer and does not crumble. Peas and rye are easily recognized by the naked eye from the shape of the fragments.

Cocoa and chocolate.—The chief adulterants in these are fats other than those of the cocoa nib. Flour is also used as an adulterant, and oxide of iron as a coloring agent when excess of flour is used. Sugar, starch, and flavoring matters are legitimate in chocolate, since it is a manufactured article, and understood to be such. The oxide of iron can be readily detected in the ash ; the flour or starch, by dissolving in water and examining the residue under the microscope. The foreign fats may be detected by extracting the fat with benzine and determining its melting point, which is about 35° C., while that of tallow is about eight or ten degrees higher. If, after separation of the fat, it is exposed to the air, it will remain sweet, if pure, but will soon become rancid if it has been adulterated with animal fats.

Flour.—This is extensively sophisticated in England and Europe, but seems in this country to be generally pure and of fair quality. The most trouble met with is from flours made of damaged wheat. These flours make dark-colored heavy bread, since they are generally deficient in gluten. Occasionally a sample of flour is met with which has been adulterated with rice or Indian-meal, but these are not at all common. Both of these adulterations can be readily detected by careful washing with water; the rice and corn flours, being heavier, sink to the bottom, when the flour and water may be poured off and the residue be examined by the microscope.

Ginger.—This article is generally sold of two grades, the pure and the colored. The colored ginger is mixed with about half its weight of turmeric, and is used for flavoring and coloring ginger-bread. Very fre-

quently other grades of ginger are sold for genuine African ginger, and it is strengthened with mustard. Additions of flour and turmeric can best be detected with the microscope.

Honey.—This is frequently largely adulterated with glucose. The only way to detect this is to incinerate a small portion and examine the ash. If it is large, 0.10 per cent. or upward, starch sugar may be suspected. Starch sugar generally contains considerable dextrine; dextrine is insoluble in strong alcohol, while honey sugar is completely soluble.

Entire absence of pollen grains in the residue left, when honey is dissolved in water, is also suspicious. Pure honey always yields more or less of the pollen of the plant from which it is derived.

Lard.—Lard should melt to a clear fat without sputtering, should be completely soluble in benzine, and should be free from any burnt odor or taste. It is frequently adulterated with lime-water and alum to improve its color and add to its weight. It is also sometimes adulterated with starch. If intended for export to southern ports, it is hardened with stearine, thus raising its melting-point.

Mustard.—This is sometimes colored with chromate of lead to give it a bright color. The presence of the metal may be detected by the ordinary tests for lead. It is also colored by turmeric, which may be detected by the microscope. It is weighted with sulphate of lime, which is shown by increased weight of ash. Good mustard yields about six per cent. of ash. The lime-lake of Persian-berries is sometimes used as a coloring matter.

Cayenne pepper.—This is said by Hassall to be colored with red lead, but recent observers have failed to find it. It is sophisticated with rice-flour, rye-flour, salt, and ship-bread. The ash is found to sometimes contain one or two per cent. of oxide of iron. This is evidently an accidental impurity, since the ash of the unground pods is colored in the same way.

Horse-radish.—Much of the grated horse-radish that is sold consists largely of turnip.

Fruit-jellies.—Many of these are what they purport to be only in name, being made from apple-jelly colored and flavored to suit the name. Some are said to contain gelatine. The coloring matters used are sometimes quite objectionable, and this is true of most of the flavors used. The safest course to pursue in regard to them is not to use them unless the source from which they come is known, and known to be trustworthy.

Milk.—This substance is the most important article of food entering into daily use, since it forms the entire or almost the entire food of children at an age when they are but little able to resist any tampering with their nourishment. From its importance and from the ease with which it is adulterated, great attention has been paid to it, and we have now the results of many thousands of analyses. Many of the earlier of these, from the methods then in use, were necessarily imperfect, and cannot well be compared with more modern work. But those made both in this country and in England, since Wanklyn published his admirable monograph upon this subject, have all been made substantially by this process, and are

consequently strictly comparable. From these analyses the following has been deduced as a standard below which pure milk should not fall. Milk can easily be kept up to this standard by proper feed and care of the cows. Any falling below it is suspicious.

	Average composition of pure milk.
Specific gravity	1.030 +
Cream, per cent. by volume	8% +
	Per cent. by weight.
Sugar	4.40
Caseine	4.30
Ash	.60
Solids not fat	9.30
Fat	3.20
Total solid	12.50
Water	87.50
	100.00

The Society of Analysts in England has adopted the following slightly lower standard:

Solids not fats	9.00
Fat	2.50
Total solids	11.50

This is too low, however, and does not give the public a fair chance. The plan which has been found best in practice here is to call all milk falling below the first standard adulterated, but not to prosecute the milkman unless it falls below the society's standard, and, in calculating results of analysis, to use the first standard. The New York Board of Health relies almost entirely upon the lactometer; but in Massachusetts, Rhode Island, Maine, and perhaps some other States, an analysis is required.

The first step to be taken in the analysis is to ascertain the specific gravity. This is either done with an ordinary hydrometer or by means of a specific gravity bottle. The hydrometers in use are graduated according to various plans. The one which has been found most convenient is a simple spindle about fifteen centimeters long. The stem of this is graduated from 0° to 40°, 0° representing pure water, 40° representing the specific gravity 1.040. This range is sufficient for all uses, and the instrument is readily carried in the pocket, and is so short that it floats in an ordinary quart-measure. With this instrument any milk that stands above 33° is pretty sure to be skimmed, while that which falls below 29° is equally sure to be watered. The advantage of this instrument over those in common use is that no standard is assumed on the instrument itself, and its findings are merely a plain statement of facts.

The New York Board of Health instrument assumes that 1.029 is the

specific gravity of pure milk, and the space between this mark and 0° is divided into 100°. On this instrument 1° represents one per cént. of milk in the sample. Thus a sample standing at 50° would consist of 50 parts of milk and 50 parts of added water.

The Orange County lactometer, which is a favorite among the milkmen, is graduated into 25°; 0° represents water, while 25° represents specific gravity, 1.040. On this instrument pure milk by the New York standard is 18.1°, or, by the standard of 1.030, 18.75°. The objection to the use of the lactometer is that very rich or warm milk stands as low as watered milk. It is best used only in the preliminary examination of milk supposed to be tampered with. If milk stands above 1.029 there is but little use in going further in the examination, unless a case of skimming can be made out ; but this last, in the absence of any legal standard, is difficult.

The creamometer consists of a glass jar about 25 mm. in diameter and 25 ctm. deep. This is graduated from 0 to 100, the 100 mark being at the bottom of the scale. The 100 c.c. mixing jars, such as are to be had at any dealers in chemical glass apparatus, answer very well. A sample of the well-mixed milk is to be poured into the jar until the upper surface of the milk corresponds to the zero mark. The jar is then to be set in a cool place for twenty-four hours, at the end of which time the amount of cream is read off. This test is very unreliable, as it is influenced by the amount of agitation which the milk has previously undergone, by the breed of the cow, and by the temperature. It is best made, however, to serve as a check on other observations. The richness of the milk may also be judged by its opacity. A milk rich in cream is much more opaque than a skimmed or watered milk. To test milk in this way, a little instrument has been devised, consisting of a small vessel with parallel sides. A given amount of water is placed in the vessel, and then the milk is added drop by drop, until a candle can no longer be seen through the solution. From the quantity of milk required to produce this opacity, its richness is determined, this being in inverse proportion to the quantity of milk used.

The next point to be determined is the amount of total solids. For this purpose, five c.c. of the milk are measured into a small platinum dish of known weight, which should have a perfectly flat bottom; the milk is then weighed accurately and placed on the water-bath and evaporated to dryness. This takes generally about an hour. It is then placed in the drying-oven, and maintained at a temperature of 100° C. for a half-hour longer, when it is again weighed. The increase in weight above the weight of the dish gives the total solids. On examination, the milk will be found to have dried in two separate layers—an upper thin skin and a lower one, which is honeycombed in appearance. Petroleum benzine, of specific gravity 70° B., or less, is then poured over this residue and allowed to stand an hour. At the end of this time the benzine is poured off—care being taken that none of the upper film is lost—and replaced by a fresh quantity. This is allowed to stand half an hour, and is then

poured off as before. The dish is finally rinsed out with a fresh portion of benzine, and is then placed in the drying-oven for half an hour, and again weighed. The loss of weight from the previous weighing gives the amount of fat in the weight taken.

The dish is then placed over a Bunsen burner and ignited until the ash becomes white. It is again weighed, and the difference between this weight and the weight of the dish gives the amount of ash.

If the milk is to be tested for sugar, 25 c.c. are precipitated with a few drops of acetic acid. The milk is best warmed to about 40° C. before precipitating. It is then cooled and filtered, and the solution made up to 500 c.c. A solution of tartrate of copper in caustic soda is used for titration of the sugar. It is prepared as follows: 34.65 grms. of pure crystallized sulphate of copper are dissolved in 200 c.c. of distilled water; 175 grms. of Rochelle salt are dissolved in 480 c.c. of a solution of pure caustic soda (specific gravity 1.14); the two solutions are mixed and made up to 1 litre. Each c.c. of the solution represents .0067 grms. of milk-sugar. This solution does not keep well; therefore it should be freshly prepared whenever wanted for use. To make the analysis, take 10 c.c. of this solution and place it in a porcelain dish with about 40 c.c. of water. Then heat to boiling, and add the whey from a burette so long as a blue color is seen in the dish, the contents of which must be kept constantly boiling.

It has been found best in practice not to rely too much on the blue color, but, when the point of saturation is nearly reached, take out a few drops with a pipette, filter through a very small filter, and test the filtrate —previously acidulated with acetic acid—with ferrocyanide of potassium, which will give a brown color so long as any copper remains in the liquid. When the point of saturation is found, it is noted, and a second trial is made to check the first, a fresh 10 c.c. of the copper solution being used. The two should agree very closely. 10 c.c. of the copper solution correspond to .067 grm. of milk-sugar. The whey used to reduce it contains, therefore, .067 grain of milk-sugar.

In order to find out how much sugar the 25 c.c. taken contained, we have this formula:

$$\frac{500 \times .067}{\text{c.c. of whey used}} = \text{weight of sugar in 25 c.c. of the milk.}$$

To find the weight in 100 c.c., this is multiplied by 4. Or 100 grms. of the milk contain this weight divided by the specific gravity of the milk.

In order to save the trouble of going through with this calculation each time, the following table has been constructed, in which the weight of sugar corresponding to each cubic centimetre of whey from 1 to 100 is given.

The numbers in the table divided by the specific gravity of the milk give at once the per cent. of sugar in the milk.

WEIGHT OF SUGAR IN 100 CUBIC CENTIMETRES.

C.C. of whey used.	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.
10	13.40	12 17	11.17	10.30	9.57	8.92	8.38	7.91	7.44	7.05
20	6.70	6.39	6.09	5.83	5.58	5.36	5.15	4.96	4.78	4.63
30	4.46	4.32	4.19	4.06	3.94	3.83	3.72	3.62	3.53	3.44
40	3.35	3.27	3.19	3.11	3.04	2.98	2.91	2.85	2.79	2.74
50	2.68	2.63	2.58	2.53	2.48	2.44	2.39	2.35	2.31	2.27
60	2.23	2.19	2.16	2.13	2.09	2.06	2.03	2.00	1.97	1.94
70	1.91	1.88	1.86	1.84	1.81	1.79	1.76	1.74	1.72	1.69
80	1.67	1.65	1.63	1.61	1.59	1.57	1.56	1.54	1.52	1.51
90	1.49	1.47	1.46	1.44	1.43	1.41	1.39	1.38	1.37	1.35
100	1.34	1.32	1.31	1.30	1.29	1.27	1.26	1.25	1.24	1.23

Of course this table can only be used when the directions given above are followed, that is, when 25 c.c. of milk are taken for the test, and the whey is made up to 500 c.c., and 10 c.c. of the copper solution are used.

To interpret the results of the analyses, we may make use of the following formulæ:

1st. Calculate the amount of pure milk from the total solids.

2d. Calculate the amount of pure milk from the solids not fat.

3d. Calculate the amount of pure milk from the sugar. The example given below is the result of an actual analysis of a watered milk. The analysis gave sugar, 3.45; caseine, 2.785; ash, .475; solids not fats, 6.71; fat, 2.31; total solids, 9.02.

Taking as our standard the average milk, given on page 366, we have, from the total solids,

$$12.5 : 9.02 :: 100 : 72.16$$

or, by this calculation, the sample contained 72.16 per cent. of average milk.

Using the solids not fat,

$$9.30 \quad 6.71 \quad 100 \quad 72.1$$

or, from this, the sample contains 72.1 per cent. of pure milk.

From the sugar

$$4.40 : 3.45 :: 100 : 78.4$$

From the specific gravity

$$30 : 21 :: 100 : 70.0$$

so, taking all these tests together, it is evident that the milk was watered at least 25 parts of added water to 75 parts of milk, or three cans of milk and one of water were mixed.

The inspector should be on the lookout for other adulterations than water, but he will find them very rare. He may, however, find cases of milk from diseased cows, or cows fed on improper food, such as brewers' swill. It is his duty to prevent the sale of such milk, if he can.

Meat.—There has been no definite line laid down between good and bad meat. Meat which some people consider just ripe, others would at once condemn. It may be laid down, however, as a safe rule to follow,

that meat, when once tainted, is not fit food for those who are not accustomed to its use.

The use of veal under four or five weeks of age is forbidden in many localities. The meat from diseased cattle is oftentimes unhealthy, though quite as frequently it may be and is eaten with impunity.

Meat infested with parasites, such as trichina spiralis, is not a safe article of food, although if properly cooked it may be eaten without danger. In order to prevent such meat as the inspector may condemn from being used as food, it should be injected with carbolic acid or some similar substance.

Oatmeal.—Much of the oatmeal sold in the market is old and rancid. To be good, the meal should be freshly ground, and it should be free from an ancient and mouse-like odor.

Pickles.—These should be examined for sulphuric acid. Mash up, treat with hot water, filter, and test the filtrate with chloride of barium. If sulphuric acid is found, the test for alum should also be made, for it is sometimes used to harden them. Incinerate several, and test the ash for alumina.

Copper should be tested for in both pickles and canned peas. Reduce the pickles to a paste in a mortar, add hot water, acidulate with sulphuric acid, insert into the mass two platinum plates connected with the poles of a battery of two or three cells, and allow them to stay in it several hours. If copper is present, it will be deposited on the platinum. It may afterward be dissolved off with a little nitric acid and be identified in the usual way with ammonia and ferrocyanide of potassium.

Preserved fruits.—A great deal of very inferior fruit is found every year on the market in the form of "apple-sauce," which is frequently pumpkin boiled in cider. The raspberry-jam offered for sale is frequently sour. Strawberry jam is often made from the refuse strawberries of the market. These can only be examined as to their general character; no specific tests can be given.

Pepper.—This is frequently adulterated with roast ship-bread, mustard-husks, and Indian-meal. These adulterations are best discovered, by comparing the sample with one known to be genuine, by aid of the microscope.

Sago is frequently potato-starch, recognizable by the microscope.

Rum.—New England rum is generally pure, though it is sometimes watered. Much of the St. Croix rum and Jamaica rum in the market is merely New England rum flavored so as to imitate the article for which it is named; a common practice being to add ten gallons of genuine rum to thirty gallons of New England.

Sugar.—In the eastern markets of the United States this article is very generally to be found in a pure state. The granulated sugar may be said to be invariably so. Very rarely a sample of light-brown sugar is met with which contains a trace of iron. A sample of sugar of this kind gives a black or brown color with tea, and has thus occasionally created some needless alarm.

It is frequently charged that the brown sugars are adulterated with

glucose. If this is done at all, it must be quite rarely; one such sample only has been met with in the last two years. In this case it was detected by the high polarization test of the goods. The ordinary glucose or starch syrup of the market is a mixture of dextrine and glucose, and polarizes very high, giving a test which represents about 150 per cent. of cane sugar. The suspected sample referred to above polarized 99°, and on examination was found to contain about 90 per cent. of cane-sugar, 9 per cent. of corn-syrup, and about 1 per cent. of water. Glucose may be readily detected from the fact that it at once reduces sodio-tartrate of copper from its solution on boiling.

Powdered sugar is sometimes adulterated with rice-flour. This is easily detected by treatment with a little sulphuric acid and tincture of iodine. The characteristic color of iodide of starch at once appears.

Molasses is frequently adulterated with glucose. Molasses always contains more or less fruit-sugar: this turns the plane of polarization to the left. Starch glucose turns it to the right. If the molasses is genuine, it should contain only cane- and fruit-sugar, and not dextrine. Cane-sugar can be readily converted into inverted sugar by heating with dilute hydrochloric acid for fifteen minutes to 68° F. Advantage may be taken of this fact to test for starch-sugar. This is not changed by the action of hydrochloric acid unless it is long continued. The polarization of the sample is therefore observed; it is then inverted, and again observed. If it still remains strongly right-handed, starch-syrup is probably present. The test for glucose with copper is worthless in this case, because the fruit-sugar that is always present reduces the copper as readily as does the starch-sugar.

Sugar is sometimes infested with mites; but these are rarely, if ever, found in refined sugars, but are mostly met with in the raw sugars as imported. Raw sugars frequently contain considerable sand, which arises from careless manipulation.

Spices.—In order to obtain these pure, and of full strength, it is almost necessary to buy them in the unground state. Ground spices, even when pure, lose strength very rapidly from the escape of the volatile oil.

The microscope furnishes almost the only guide to their purity. It is well, however, to determine the amount of ash, and compare it with the ash of genuine samples. The addition of starches and flour lowers the ash, while terra alba raises it.

Tea.—Tea is said to be adulterated with leaves other than those of the tea-plant. These are best detected by soaking the leaf, and then spreading it out flat, and comparing it with tea-leaves known to be genuine.

Exhausted tea-leaves are said to be shipped from China to this country. These can best be detected by exhausting a weighed quantity of the tea with hot water, and then evaporating the extract to dryness; it should leave a residue of at least twenty-five per cent. of the weight of the tea. Sand and dirt are frequently found in low-grade teas. The ash of tea should not exceed six per cent. Weighted teas frequently contain from twenty to thirty per cent. of ash. The tea should be carefully ex-

amined for facing material, such as black-lead, Prussian blue, and soapstone.

Vinegar.—The British law allows an amount of sulphuric acid or sulphates in vinegar which shall not exceed one-tenth of one per cent. Any amount above this allowance should be regarded as an adulteration. Chlorides in quantities of more than one-tenth of one per cent. should also be absent. Good vinegar should only give a cloudiness with chloride of barium, or with nitrate of silver. Burnt sugar, or caramel, is sometimes used to color vinegar. As this is done to please the eye, and is not injurious, it can hardly be regarded as an adulteration. Good vinegar should contain at least three per cent. of acetic acid; anything below this must be regarded as watered.

Wine.—In order to define what is an adulteration in wine, it is first necessary to understand what wine is. Some authors assume that wine is the pure, fermented juice of the grape. But this definition of wine at once excludes a very large class of wines. It would exclude the whole of the ports, sherries, and champagnes, which are rarely, if ever, sent into the market without undergoing some manipulation for the purpose of adding to their strength, flavor, or keeping properties. Sherries and port are almost invariably plastered and fortified. A natural port or sherry should not contain in each litre over 120 or 130 grms. of alcohol. The commercial ports and sherries contain, however, from 170 to 190 grms. of alcohol in the litre. Of this alcohol at least fifty to sixty grms. are added. This is apt to be in the form of brandy of a very poor quality. The ash of pure wine should not contain more than one grm. of sulphates to the litre; but the ash of a litre of port or sherry generally contains from three to four grms. of sulphates. This large increase in sulphates arises from the practice of dusting the grapes with sulphate of lime. The sulphate of lime decomposes the acid tartrate of potassium in the fruit, producing sulphate of potassium in the wine, while the tartrate of calcium is deposited in the lees.

This plastering of the wine is excused on various grounds. That it is injurious hardly admits of question; but at present it has to be submitted to, since it is impossible to obtain sherry or port that has not been so treated.

The next sophistication to which wine is submitted during its manufacture is sweetening with sugar. In bad years the grapes are poor, and yield a thin, acid juice. In order that the fermentation may produce sufficient alcohol to keep the wine, it is customary to add sugar to the must.

Sometimes the flavor is deficient. In order to improve this, the wine-merchant keeps a supply of old, high-flavored wines, which he adds to the poor wine.

If the color is deficient in the case of port and other red wines, elderberry-juice is added to produce the desired shade. In the case of sherries, caramel is used. Champagne is a manufactured wine, having for its basis the juice of a black grape growing in the Champagne district in France. The bottlers of champagne flavor it, fortify it, and sweeten it

according to private formulas, so as to imitate as nearly as possible their well-known brands. The main difference between the vintages of various years being in the good or poor quality of the wine they start upon. Only one thing can be relied upon in regard to champagne, and that is the fact that it is not the *pure*, fermented juice of the grape. It is just as much an artificial production as the various cordials which are found in the market.

So far only what may pass as reasonably pure wines have been spoken of—that is, wines which come from the places where such wines originate and which are free from adulteration other than what custom and long usage have sanctioned.

Factitious wines, that have never been within the limits of the wine-growing districts, are also to be found in the market. It is estimated that the Champagne district in France does not produce more than one-tenth of the amount of champagne consumed, the remainder being manufactured from cider and other wines.

Many very elaborate analyses of wines have been made, the most elaborate monograph on the subject being Thudichum and Dupré's treatise on the Origin, Nature, and Varieties of Wine, in which may be found full directions for making minute analyses of wine and also such analyses of all the leading wines of the world.

In ordinary commercial tests only a very few determinations are made. It is well to take the specific gravity of the wine. This is best done in the ordinary specific gravity flask. The alcohol is also determined. This may be done in two ways: either by distilling 200 or 300 c. ctm. of the wine and collecting and determining the specific gravity of the distillate; or by evaporating a measured amount of the wine on the water-bath to one-fourth of its volume, and adding water to the residue until its former volume is restored, when the specific gravity is again determined. The specific gravity of the entire wine divided by the same dealcoholized gives very closely the specific gravity of the alcohol contained in the wine. Having the specific gravity, the percentage is readily found by referring to any alcohol tables.

The total solids should also be determined. This may be done by evaporating from 10 to 50 c.c. of the wine to dryness in a platinum dish. If the wine is a very sweet one, only 10 c.c. should be taken. The residue should be dried at a temperature not exceeding 105° C. and then weighed. For the same kind of wine this residue is quite constant in weight, not varying generally more than one or two per cent. After weighing the residue, it is to be ignited at a very low red heat until the ash is white, and the amount of ash is determined by again weighing and subtracting the weight of the dish.

In red wines an examination should also be made for artificial coloring matters. Very elaborate tables have been given for the detection of various coloring matters. As a general rule, the coloring matters used are harmless, and the only object in detecting them is to show whether the wine has been adulterated. The only one that is at all likely to be harmful is fuchsine or magenta. This is most easily detected by concentrating

the wine and then dyeing a piece of wool with the solution. Cochineal and fuchsine will give a red or pink color on wool. The coloring matter of wine does not dye wool without a mordant. A very elaborate paper, by M. Gautier, was published in the Analyst for 1877, which may be consulted on this point.

Beer.—This is examined in exactly the same manner as wine.

In concluding, one or two other articles, which do not come strictly under the heading of food, may be noticed.

Cream of tartar.—Much of what is to be found in the market under this name is more or less adulterated. The favorite adulteration is terra alba or gypsum. This may vary from 5 to 75 per cent. Common commercial cream of tartars average about 93 per cent. of cream of tartar and 7 per cent. of tartrate of calcium, and only contain traces of sulphates.

The examination most conveniently made is the following: Five grms. are dissolved in hot water with the addition of a few drops of hydrochloric acid. Ammonia is then added in excess, and then oxalate of ammonia. This is allowed to stand an hour or so, and then filtered. The filter is well washed with ammonia-water, and then dried and ignited over a blast-lamp for ten minutes in a platinum crucible. The residue, after ignition, consists of caustic lime, CaO. Another five grms. are dissolved in the same manner as before, and chloride of barium is added to the solution. The precipitate, if any is formed, consists of sulphate of barium. It is collected on a filter, dried, ignited, and weighed. The weight of the precipitate, multiplied by .7382, gives the weight of the corresponding amount of gypsum. This, multiplied by 100 and divided by the weight taken, gives the per cent. of gypsum in the sample.

The per cent. of gypsum multiplied by .3256 gives the amount of lime, CaO, in the gypsum. This lime is to be subtracted from the lime found in the sample. The remainder of the lime multiplied by 4.642, gives the amount of tartrate of calcium in the sample.

Example: A certain cream of tartar gave 6.773 per cent. sulphate of baryta and 3 per cent. of lime.

$$
\begin{aligned}
6.773 \times .7382 &= 5. = \text{per cent. gypsum.}\\
5. \times 3256 &= 1.628 = \text{lime.}\\
3. - 1.63 &= 1.37.\\
1.37 \times 4.642 &= 6.36 = \text{per cent. tartrate of lime.}
\end{aligned}
$$

If the cream of tartar is dirty and does not dissolve completely in acid, then the solution must be filtered before precipitation, the filter ignited and weighed, and the percentage of insoluble matter calculated.

It is a good plan to always ignite five grms. of the tartar in a platinum dish and weigh the ash. Pure cream of tartar yields 36.79 per cent. of ash; tartrate of lime yields 21.54 per cent. of ash. The ash, as calculated from the amount of tartrate of lime found, and from the amount of cream of tartar, as determined by subtracting the tartrate of lime from

100, should very closely agree with the amount of ash actually found. In the presence of gypsum, however, the ash found is always too low, as part of the sulphuric acid is lost during ignition.

If the sample is adulterated with rice-flour, the ash will also be low. A few samples have recently been found in the market which contained bitartrate of ammonia. The lowness of the ash in this case led to the detection of the ammonia.

Starch of any kind may be detected by the iodine test, and, after dissolving out the bitartrate with cold water, identified with the microscope.

Occasionally samples sold as cream of tartar are met with which are free from any bitartrate. One of the favorite forms is: Tartaric acid, one-third; gypsum, one-third; and rice flour, one-third.

Occasionally a sample is found badly adulterated with alum or with acid sulphate of soda, or salt-cake. These are both easily detected, though a mixture of alum and rice flour occasionally bothers the analyst.

A cream of tartar substitute, composed of acid phosphate of lime and potato-starch, is sometimes sold as cream of tartar. This, if well made, is unobjectionable, but should be sold under its proper name.

Baking-powders.—Those in the market at present are composed either of cream of tartar and bicarbonate of soda, or of cream of tartar, bicarbonate of soda, and rice-flour; the object of the addition of the rice-flour being to keep the tartar and bicarbonate apart, so that they will not react on each other until the proper time.

Another formula consists of ammonia alum, starch and bicarbonate of soda. This makes an excellent powder, so far as the production of a baking-powder is concerned. But there is much controversy in regard to its healthfulness.

The compound which seems to have the best arguments in its favor is the mixture of acid phosphate of lime and bicarbonate of soda, since this restores to the flour the phosphates that have been removed in the bran.

Tinware.—Much complaint has been recently made that the cheap tinware sold is made from terne plate, and has given rise to cases of lead poisoning. Terne plate has not the bright appearance of good tin plate, but has a dull leaden hue. To test it, scrape off a little of the coating, dissolve in aqua regia, dilute and pass through the solution a strain of sulphide of hydrogen. The formation of a dark precipitate indicates the presence of lead. The test sometimes given, of putting a drop of nitric acid on the article, then warming until the acid has evaporated, and finally moistening with iodide of potassium, is worthless. Pure tin gives almost exactly the same shade of color with this test as lead.

Poisonous glazing or enamel.—A few years ago there suddenly appeared on the market large quantities of glazed ironware which contained lead and arsenic in a form which was soluble in weak acids. To test such ware, boil dilute nitric acid in it, then test the acid in the usual way for lead and arsenic.

Poisonous papers.—Almost all of the bright green glazed paper, so freely used in stores for fancy boxes, contains arsenic in large quantities.

It should be condemned whenever met with. It has been found as a covering for lozenges, and is used for all kinds of tickets.

To conclude: the health officer cannot be too vigilant in his search for adulteration, nor too circumspect, when the adulteration is found, in condemning it. He must be perfectly sure that he is right, and must throw all personal feelings in the matter to one side, for nothing so prejudices a case as to have it appear that the officer has any object in view other than the performance of his duty; and in the large number of cases he will find his purposes served far better by warning the parties privately than he will by bringing the case into court. Any repetition of the offence, however, should be followed by prompt action.

BIBLIOGRAPHY.

The bibliography of the subject of adulteration of food is extensive, and is being very rapidly augmented. The works enumerated below are most of them quite recent, and cover the ground very fully. Blyth's Manual and Hassall's Treatise on Food are indispensable. Hassall's engravings of articles of food, as seen under the microscope, have never been surpassed. For a very complete and exhaustive bibliography of the subject the reader is referred to Blyth's Manual and Naquet's Legal Chemistry.

Accum, Frederick: A Treatise on Adulteration of Food, and Culinary Poisons. London, 1820.

This work is mainly interesting as being the first attempt in English of a systematic presentation of the subject. It is generally referred to as "Death in the Pot," from the woodcut on the title-page.

The Analyst. London, 1877.

This is the official journal of the Society of Public Analysts of Great Britain. It contains a full report of their proceedings, and gives the latest intelligence in regard to the methods of detecting adulterations.

Blyth, A. Wynter: A Manual of Practical Chemistry, the Analysis of Foods, and Detection of Poisons. London, 1879.

Blyth, A Wynter: Dictionary of Hygiene and Public Health. London, 1876.

Cameron, C. A.: Chemistry of Food. London, 1868.

Fox, C. B.: Sanitary Examinations of Water, Air, and Food. London, 1878.

Griffin, J. J.: The Chemical Testing of Wine and Spirits. London, 1872.

Hassall: Adulterations detected in Food and Medicine. 1st ed. London, 1854.

This work is out of print, and very difficult to obtain. The engravings, being the first impressions from the blocks, are much sharper than in later editions.

Hassall: Food, its Adulterations and the Methods for their Detection. London, 1876.

This is substantially a third edition of the preceding work. A few new cuts have been introduced, and the work has been extended and partially rewritten. Dr. Hassall's works have been for over twenty years the standard on this subject.

Husson, C.: Le lait, la crême, et le beurre. Paris, 1878.

Letheby: On Food. London and New York, 1872.

Kensington: Analysis of Foods. London, 1877.

This is quite a full collection of the analysis of various kinds of food.

Mitchell, John: Treatise on the Falsification of Food. London, 1848.

Naquet, A.: Legal Chemistry. Translated by J. P. Battershall. New York, 1876.

This work contains a very full bibliography of works relating to the subjects of foods and poisons.

Normandy. Edited by Noad: The Commercial Handbook of Chemical Analysis. London, 1875.

Pavy: Food and Dietetics. London and Philadelphia, 1874.

Smith, Elward: Foods. London and New York, 1873.

Smith, Edward: Manual for Medical Officers of Health. London, 1874.

Smith, Edward: Handbook for Inspectors of Nuisances. London, 1873.

These last two works contain the full text of the English laws upon the subject of food and its adulterations.

Soubeiran, E.: Dictionnaire des falsifications. Paris.

This work is, to a considerable extent, a doing over into French of Hassall's work, but contains also considerable original matter.

Thudichum and Dupré; A Treatise upon the Origin, Nature, and Varieties of Wine. London, 1872.

This is one of the best works ever published on the subject of wine. It contains very full analyses of all the principal varieties of wine.

Wanklyn: Milk Analysis. London, 1873.

This little work created a revolution in the methods of analysis of milk; and Wanklyn's methods, with slight modifications, have become the standards for the analysis of milk.

Wanklyn: Tea, Coffee, and Cocoa. London, 1876.

PUBLIC NUISANCES.

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PUBLIC NUISANCES.

Blackstone defines a nuisance as an "annoyance; anything that worketh hurt, inconvenience, or damage." A definition like this, which is comprehensive enough to include a hurricane or the rupture of a blood-vessel, is manifestly unsuited to our purpose. In Burrill's Dictionary of Law Terms, a common or public nuisance is said to be "a nuisance affecting the public, being an annoyance to the whole community in general, as distinguished from a private nuisance, which is confined in its effects to particular individuals." This definition is defective, because a nuisance may be a public one without being "an annoyance to the whole community in general." A factory, for instance, in a large town, may make the atmosphere unwholesome for two or three blocks on every side, and thus be decidedly a public nuisance, while people of the same community living farther away may not even know of its existence. On further investigation I find that the legal conception of a public nuisance includes lotteries and common scolds, and it thus becomes evident that a more restricted definition must be framed for a book on hygiene.

It will not do to limit the application of the term "nuisance" to that which directly affects the health of individuals or the community, because their physical well-being may be prejudiced by exposure to anything that interferes with their comfort or convenience. Impartial testimony, for example, goes to show that the disagreeable emanations from fat-and bone-boiling establishments are not injurious to health, but rather the contrary, and still such establishments are so obnoxious that they are undeniably public nuisances, because no one can live near them in comfort, unless his senses are blunted by constant association. We must consider anything which interferes with the comfort, then, as a nuisance, as well as that which injures the health directly.

The most difficult question is that of the proper meaning of the word "public" in this connection. A nuisance may be a public one and still affect only a part of the community in which it exists. But how large a part must this be? Anything which is a nuisance only to the persons on the premises where it originates cannot be considered a public nuisance, for the occupants of a single lot or a single building must be looked upon as a social unit, as a single integral part of the community, anything which they may say, do, or feel by themselves, not partaking of a public

character. Neither, in my opinion, does a nuisance become a public one when it affects the occupants of a single adjoining or neighboring lot or building only, for the very fact of its being limited to a single spot outside of the premises where it originates shows that it is a nuisance to that spot, or to the occupants of that lot or building, by virtue of some particular quality which does not extend and is not likely to extend to any place beyond.

But when anything becomes a nuisance to the occupants of two premises other than the premises on which it originates, it seems to me that it becomes a public nuisance, for it now takes on a quality of extension, and if its obnoxious character affects the occupants of premises in two directions, or of two premises in one direction, it is an indication that it only needs to be a little more intense, or to exist under slightly different circumstances (as varying winds, barometric pressure, temperature, etc.), to become a nuisance to a still greater number of people. The number of persons who must be affected in order to constitute anything a public nuisance, has, in any event, to be fixed upon arbitrarily, and I have preferred to put the dividing line between a private and a public nuisance at the point where we pass from unity to plurality. Accordingly, I shall define a *public nuisance to be anything that injuriously affects the health or comfort of the occupants of two or more premises other than the premises on which it exists.*

The suppression of public nuisances is a governmental duty, but it is not to be presumed that any business or trade which becomes a public nuisance is necessarily to be driven away from the haunts of men. It is always to be borne in mind that what is a nuisance to one man is to another the means by which he earns his bread, and it is not always an easy matter for the public authority to decide between the demands of a few or many persons on the one hand, whose health or comfort is interfered with, and the inexorable demands of commerce on the other. Many trades are obnoxious to those who live near the places where they are carried on, which cannot be far removed from inhabited localities. The slaughtering of animals is such a one, for the flesh cannot be transported far without becoming unwholesome or expensive. So, too, the noise and other nuisances connected with railroads have to be endured, because the roads are of no use unless they end in a populous community. Indeed, in the vast majority of cases, the attention of public officials must be directed toward a reduction of any nuisance to a minimum, rather than toward its entire abolition, for the latter often implies the extinction of the business. The most serious nuisances are those arising from the various processes of manufacture, and in the tremendous development of industrial activity in every direction of late years there has been a corresponding increase in the number and harmfulness of the noxious influences to which communities are exposed.

The poisoning of the atmosphere by emanations from industrial establishments has gone farther in England than in any other country. Acid fumes from soda and superphosphate works, and clouds of coal-smoke,

with carbonic and sulphurous acids, from every factory chimney, began to produce an appreciable effect on vegetation, and on the health of men and animals. Within a few years strenuous efforts have been made to control this growing nuisance, and with considerable success. The various means resorted to will be mentioned under the appropriate headings.

In France also, and especially in Paris, much attention has been given to the abatement of public nuisances. In this direction, as in so many others, the influence of Napoleon the Great is still felt. By an imperial decree of October 15, 1810, all establishments which could be considered nuisances, by reason of their injuring the health or causing inconvenience or discomfort to persons living in their vicinity, were divided into three classes, according to the degree of nuisance caused by them. The *first* class includes all businesses which must be removed from the neighborhood of dwelling-houses. Most of them are not allowed within three hundred metres of an inhabited building. The *second* class includes those businesses which need not necessarily be removed from the vicinity of dwelling-houses, but which require special permission for their establishment, cannot be started without the consent of neighbors, and are always to be kept under surveillance by the police or local inspectors, who see that they are properly conducted. The *third* class includes those businesses which may be established without the formalities required of those in the first and second classes, but must still obtain permission from the local authorities, and must remain more or less under the surveillance of the police or other official.

Since this classification was made, some manufacturing processes have fallen into disuse, and many new ones have been introduced, while the methods of many have been so changed as to relieve them, more or less, of the qualities which made them obnoxious. There have been corresponding changes in the classification, businesses being shifted from one class to another, or dropped entirely, and new ones introduced, up to the year 1866, when the latest classification was made and promulgated by an imperial decree, dated December 31, 1866.

As France is the only nation that has made such a classification of businesses up to the present time, and as it forms a convenient table for reference in connection with the subject of this chapter, the classification of 1866 is given on the following pages:

FIRST CLASS.

Business.	Character of Nuisance.	Business.	Character of Nuisance.
Abattoirs, public.	Smell, pollution of water.	*Crude Soda*, from sea-weed, manufacture of, in permanent establishments.	Smell, smoke.
Acid, Arsenic, manufacture of, by means of arsenious and nitric acids, when the nitrous products are not absorbed.	Injurious vapors.	*Cyanide of Potassium* and *Prussian Blue*, manufacture of, by direct calcination of animal matters with potash.	Smell.
Acid, Hydrochloric, production of, by decomposition of the chlorides of magnesium, aluminium, etc., when the acid is not condensed.	Injurious emanations.	*Dirt* and *Rubbish*, depôts of, and *Dumps*.	Smell.
Acid, Oxalic, manufacture of, by nitric acid, without destruction of noxious gases.	Fumes.	*Dogs*, hospitals for.	Smell, noise.
Acid, Picric, when the noxious gases are not burned.	Injurious vapors.	*Earths* containing pyrites and aluminas, roasting of.	Smoke, injurious emanations.
Acid, Stearic, manufacture of, by distillation.	Smell, danger of fire.	*Ether*, manufacture and depôts of.	Danger of fire and of explosion.
Acid, Sulphuric, manufacture of, by the combustion of sulphur and pyrites.	Injurious emanations.	*Fat-rendering*, establishments for, over open fire.	Smell, danger of fire.
Nordhausen process, by the decomposition of sulphate of iron.	Injurious emanations.	*Felt* and *Glazed Visors*, manufacture of.	Smell, danger of fire.
Aldehyde, manufacture of.	Danger of fire.	*Fertilizers*, depôts of (matters coming from night-soil or offal, unmanufactured, or in an uncovered storehouse).	Smell.
Archil, manufacture of, in covered kettles.	Smell.	*Fertilizers*, manufacture of, by means of animal matters.	Smell.
Arsenite of Potash, manufacture of, by means of saltpetre, when the vapors are not absorbed.	Injurious emanations.	*Fireworks*, manufacture of.	Danger of fire and explosion.
Axle-grease, manufacture of.	Smell, danger of fire.	*Fish-oil*, manufacture of.	Smell, danger of fire.
Blood, depôt of, for the manufacture of Prussian blue and other industries.	Smell.	*Flesh, Scraps* and *Offal* from the slaughtering of animals, depôts of.	Smell.
Blood, manufacture of powder from, for the clarification of wines.	Smell.	*Fulminate of Mercury* manufacture of.	Danger of explosion and fire.
Blood, works for separating the fibrin, albumen, etc.	Smell.	*Fuse*, manufacture of, with explosive materials.	Danger of explosion and fire.
Bone-fat, manufacture of.	Smell, pollution of water, danger of fire.	*Glue*, manufacture of.	Smell, pollution of water.
Bones, drying of, for manure, when the gases are not burned.	Smell, danger of fire.	*Gold* and *Silver Refining*, by acids.	Injurious emanations.
Bones, fresh, depôts of, on a large scale.	Smell, injurious emanations.	*Grease* or *Thick Oil*, for the use of the makers of chamois leather, or curriers, manufacture of.	Smell, danger of fire.
Brown Grease, manufacture of.	Smell, danger of fire.	*Guano*, depôts of, when amount exceeds 25,000 kilogrammes.	Smell.
Burning of Sea-weed, in permanent establishments.	Smell, smoke.	*Gut-cleaning* establishments, handling of fresh intestines for all purposes.	Smell, injurious emanations.
Carbonization of animal matters in general.	Smell.	*Hogs' Bristles*, preparation of, by fermentation.	Smell.
Chrysalids, shops for the extraction of the silky portions of.	Smell.	*Ivory Black* and *Animal Black* (distillation of bones or manufacture of) when the gases are not burned.	Smell.
Coke, manufacture of, in open air, or in furnaces without smoke-consumers.	Smoke, dust.		

Business.	Character of Nuisance.
Knackeries.	Smell, injurious emanations.
Lignite, incineration of.	Smoke, injurious emanations.
Matches, manufacture of, with explosive materials.	Danger of fire and explosion.
Menageries.	Danger from animals.
Neat's-foot Oil, manufacture of, by using matters already putrescent.	Smell.
Nitrate of Iron, manufacture of, when the injurious vapors are not absorbed or decomposed.	Injurious emanations.
Oils and other fatty matters, extraction of, from the débris of animal matters.	Smell, danger of fire.
Oils, mixing by heat or boiling of, in open kettles.	Smell, danger of fire.
Oils of petroleum, schist and tar, essences and other hydrocarbons employed in lighting, warming, manufacture of colors and varnishes, scouring of cloth and other uses, manufacture, distillation and handling of, on a large scale.	Smell, danger of fire.
Olive-cakes, treatment of by sulphide of carbon.	Danger of fire.
Patent Leather, manufacture of.	Smell, danger of fire.
Pearl Ash, with discharge of smoke externally.	Smoke, smell.
Peat, carbonization of, in open vessels.	Smell, smoke.
Percussion Caps, manufacture of.	Danger of explosion.
Petroleum, etc., depôts of.	Smell, danger of fire.
1. Substances very inflammable, that is, with a flashing-point below 35° C., if the quantity stored is even temporarily 1,050 litres or more.	
2. Substances less inflammable, that is, with a flashing-point of 35° C. or over, if the quantity stored is even temporarily 10,500 litres or more.	Smell, danger of fire.
Phosphorus, manufacture of.	Danger of fire.
Piggeries.	Smell, noise.
Poudrette and other manures, manufacture of, out of animal matters.	Smell, pollution of water.
Powder and fulminating matters, manufacture of.	Danger of explosion and fire.
Printing Ink, manufacture of.	Smell, danger of fire.
Prussian and *English Red.*	Injurious emanations.
Red Oils, manufacture of, by extraction from scraps and fatty residues, at a high temperature.	Smell, danger of fire.
Resin Oils, manufacture of.	Smell, danger of fire.
Resins, *Galipots* and *Common Rosin*, works on a large scale for the melting and clarifying of.	Smell, danger of fire.
Retting of hemp and flax, on a large scale.	Injurious emanations, pollution of water.
Roasting of minerals containing sulphur.	Smoke, injurious emanations.
Sabots, shops for smoking, by the burning of horn or other animal matters, in towns.	Smell, smoke.
Scalding-houses for the industrial preparation of offal.	Smell.
Scouring of woollen goods and waste by petroleum oils and other hydrocarbons.	Danger of fire.
Scraps, manufacture of.	Smell, danger of fire.
Slops, extraction of the fatty matters contained in, for the manufacture of soap and other uses, in open kettles.	Smell, danger of fire.
Starch, manufacture of, by fermentation.	Smell, injurious emanations.
Sulphate of Ammonia, manufacture of, by distillation of animal matters.	Smell.
Sulphate of Copper, manufacture of, by roasting pyrites.	Injurious emanations, smoke.
Sulphate of Mercury, manufacture of, when the vapors are not absorbed.	Injurious emanations.
Sulphate of Soda, manufacture of, by the decomposition of sea-salt by sulphuric acid, without condensation of the hydrochloric acid.	Injurious emanations.
Sulphide of Carbon, manufacture of.	Smell, danger of fire.
Sulphide of Carbon, manufactories in which it is used on a large scale.	Danger of fire
Taffetas and glazed or waxed cloths, manufacture of.	Smell, danger of fire.
Tarpaulins, manufacture of, with the boiling of oils.	Danger of fire.
Tars and vegetable resins of different kinds, elaboration of.	Smell, danger of fire.
Tars of different origins, special works for the elaboration of.	Smell, danger of fire.
Tobacco, incineration of the midribs of.	Smell, smoke.
Triperies connected with abattoirs.	Smell, pollution of water.
Varnish, Oily, manufacture of.	Smell, danger of fire.

SECOND CLASS.

Business.	Character of Nuisance.	Business.	Character of Nuisance.
Acid, Arsenic, manufacture of, by means of arsenious and nitric acids, when the nitrous products are absorbed.	Injurious emanations.	*Cooperage* on a large scale, using casks impregnated with oily and putrescent matters.	Noise, smell, smoke.
Acid, Hydrochloric, production of, by the decomposition of the chlorides of magnesium, aluminium, etc., when the acid is condensed.	Accidental emanations.	*Currying* establishments.	Smell.
Acid, Oxalic, manufacture of, with sawdust and potash.	Fumes.	*Cyanide of Potassium* and *Prussian Blue*, manufacture of, by using matters previously carbonized, in close vessels.	Smell.
Acid, Pyroligneous, manufacture of, when the gaseous products are not burned.	Smoke, smell.	*Dairies*, on a large scale, in towns.	Smell.
Acid, Pyroligneous, purification of.	Smell.	*Enamelled Ware*, manufacture of, with non-smoke-consuming furnaces.	Smoke.
Acid, Stearic, manufacture of, by saponification.	Smell, danger of fire.	*Engines* and *Cars*, shops for the construction of.	Noise, smoke.
Alcohol, rectification of.	Danger of fire.	*Faïence*, manufacture of, with non-smoke-consuming furnaces.	Smoke.
Alkaline Chlorides, Eau de Javelle, manufacture of.	Smell.	*Fat-rendering*, establishments for, by water-bath or by steam.	Smell.
Arsenite of Potash, manufacture of, by means of saltpetre, when the vapors are absorbed.	Accidental emanations.	*Felt, tarred*, manufacture of.	Smell, danger of fire.
Artificial Fuel, or bricks of coal, manufacture of, with fat resins.	Smell, danger of fire.	*Fertilizers*, depôts of, matters coming from night-soil or offal, dried or disinfected, and in a covered storehouse, when the quantity exceeds 25,000 kilogrammes.	Smell.
Asphalt and *Bitumen*, works, with open fire.	Smell, danger of fire.	*Fish*, shops for salting and smoking.	Smell.
Baryta, decoloration of the sulphate of, by means of hydrochloric acid, in open vessels.	Injurious emanations.	*Forges* and *Boiler-works* for large pieces, employing trip-hammers.	Smoke, noise.
Black of refineries and sugar-houses, revivification of.	Smell, injurious emanations.	*Gas*, for illuminating and heating, manufacture of, for public use.	Smell, danger of fire.
Blast-furnaces.	Smoke, dust.	*Glass* (common, flint, and plate), manufacture of.	Smoke.
Bleaching of threads, textures, and paper pulp, by chlorine.	Smell, injurious emanations.	*Gold* and *Silver Laces* and tissues, establishments for burning on a large scale, in towns.	Smell.
Of threads and textures of wool and silk, by sulphurous acid.	Injurious emanations.	*Green Leather* and fresh hides, depôts of.	Smell.
Bones, torrefaction of, for manure, when the gases are burned.	Smell, danger of fire.	*Illuminating Fluids* made of alcohol and essential oils, depôts of.	Danger of fire and explosion.
Carpet-beating, on a large scale.	Noise, dust.	*India Rubber*, application of coats of.	Danger of fire.
Chamois Leather, manufacture of.	Smell.	*India Rubber*, manufacture of, with essential oils or sulphide of carbon.	Smell, danger of fire.
Chloride of Lime, manufacture of, on a large scale.	Smell.	*Ivory Black* and animal black (distillation of bones or manufacture of), when the gases are burned.	Smell.
Chlorine, manufacture of.	Smell.	*Lamp-black*, manufacture of, by distillation of coal, tar, bitumen, etc.	Smoke, smell.
Cleaning of rabbit and hare skins for felt.	Smell.	*Lime-kilns*, permanent.	Smoke, dust.
Cocoons, treatment of the envelopes of.	Pollution of water.		
Codfish, places for drying.	Smell.		
Coke, manufacture of, in smoke-consuming furnaces.	Dust.		

Business.	Character of Nuisance.
Murexide, manufacture of, in closed vessels, by the reaction of nitric acid with the uric acid of guano.	Injurious emanations.
Neat's-foot Oil, manufacture of, when the matters used are not putrefied.	Smell.
Nitro-benzol, *Aniline*, and matters derived from benzine, manufacture of.	Smell, injurious emanations, danger of fire.
Oiled textures for packing, tissues, tarred cords, tarred paper, bitumenized pasteboard and tubes, manufacture of.	Smell, danger of fire.
Oils, mixing by heat or boiling of, in close vessels.	Smell, danger of fire.
Oils of petroleum, schist and tar, essences and other hydrocarbons used for lighting, heating, manufacture of colors and varnishes, the scouring of cloth, and other uses.	Smell, danger of fire.
1. Depôts of substances very inflammable, that is, with flashing-point below 35° C. If the quantity over 150 litres does not reach 1,050 litres.	Smell, danger of fire.
2. Substances less inflammable, that is, with a flashing-point of 35° C. or over. If the quantity stored over 1,050 litres does not reach 10,500 litres.	Smell, danger of fire.
Onions, drying of, in towns.	Smell.
Parchment factories.	Smell.
Pearlash, with burning or condensation of the smoke.	Smoke, smell.
Peat, carbonization of, in close chambers.	Smell.
Pigs' Hairs and *Bristles*, preparation of, without fermentation.	Smell, dust.
Plaster-kilns, permanent.	Smoke, dust.
Porcelain, manufacture of, with non-smoke-consuming furnaces.	Smoke.
Potash, manufacture of, by calcination of the residue of molasses.	Smoke, smell.
Protochloride of Tin, or salt of tin, manufacture of.	Injurious emanations.
Refineries and sugar-houses.	Smoke, smell.
Retting, on a large scale, of hemp and flax, by the action of acids, warm water, and steam.	Injurious emanations, pollution of water.
Roe, depôts of liquid salted stuff known under the name of.	Smell.
Sal Ammoniac extracted from the ammoniacal liquor of gas-works.	Smell.
Sal Ammoniac and sulphate of ammonia, manufacture of, by the use of animal matters.	Smell, injurious emanations.
Salted Fish, depôts of.	Unpleasant smell.
Sardines, factories of preserved, in towns.	Smell.
Sausages, manufacture of, on a large scale.	Smell.
Silk Hats, or others prepared by means of a finish, manufacture of.	Danger of fire.
Slaughter-houses.	Danger from the animals and smell.
Slops, extraction of the fats contained in them for the manufacture of soap and other uses, in closed vessels.	Smell, danger of fire.
Starch, manufacture of, by separation of gluten, and without fermentation.	Pollution of water.
Stripping of hemp, flax, and jute, on a large scale.	Dust, noise.
Sulphate of Mercury, manufacture of, when the vapors are absorbed.	Injurious emanations in a less degree.
Sulphate of the Peroxide of Iron, manufacture of, by the sulphate of the protoxide of iron and nitric acid, nitro-sulphate of iron.	Injurious emations.
Sulphate of Soda, manufacture of, with complete condensation of the hydrochloric acid.	Injurious emanations.
Sulphur, fusion or distillation of.	Injurious emanations, danger of fire.
Tanneries.	Smell.
Tarpaulins, manufacture of, without boiling oils.	Danger of fire.
Tars and fluid bituminous substances, depôts of.	Smell, danger of fire.
Tars, treatment of, in the gas-works where they are produced.	Smell, danger of fire.
Tobacco, manufacture of.	Smell, dust.
Tobacco-pipes, manufacture of, with non-smoke-consuming furnaces.	Smoke.
Torches, *resinous*, manufacture of.	Smell, danger of fire.
Varnish, manufacture of, with spirit of wine.	Smell, danger of fire.
Wood-charcoal, manufacture of, in the open air, in permanent establishments, elsewhere than in the forest.	Smell, smoke.
In closed chambers, with the discharge into the air of the gaseous products of distillation.	Smell, smoke.

THIRD CLASS.

Business.	Character of Nuisance.	Business.	Character of Nuisance.
Acid, Nitric, manufacture of.	Injurious emanations.	*Chloride of Lime*, manufacture of, in shops making at the most 300 kilogrammes a day.	Smell.
Acid, Oxalic, manufacture of, by nitric acid, with destruction of the injurious gases.	Accidental fumes.	*Chromate of Potash*, manufacture of.	Smell.
Acid, Picric, manufacture of, with destruction of injurious gases.	Injurious vapors.	*Coal-washing* places.	Pollution of water.
Acid, Pyroligneous, manufacture of, when the gaseous products are burned.	Smoke, smell.	*Coffee*, roasting of, on a grand scale.	Smell, smoke.
Albumen, manufacture of, by means of fresh blood-serum.	Smell.	*Copper*, brass, and bronze foundries.	Metallic fumes.
Alcohols, agricultural distillery.	Pollution of water.	*Copper*, cleaning of, with acids.	Smell, injurious emanations.
Alcohols other than from wine, without rectifying works.	Pollution of water.	*Cotton* and oily cotton, bleach-works for the waste of.	Pollution of water.
Ammonia, manufacture of, on a grand scale, by decomposition of ammoniacal salts.	Smell.	*Cow-yards*, in towns of more than 5,000.	Smell, and drainage of urine.
Ammoniacal Cochineal, manufacture of.	Smell.	*Distilleries* in general, brandy, gin, cherry-brandy, absinthe, and other alcoholic liquors.	Danger of fire.
Archil, manufacture of, in closed vessels, using ammonia to the exclusion of urine.	Smell.	*Drug-mills.*	Noise, dust.
Artificial Fuel, or bricks of coal, manufacture of, with dry resins.	Smell.	*Dyeing of Leather*, shops for.	Smell.
Asphalts, bitumens, resins and solid bituminous matters, depôts of.	Smell, danger of fire.	*Dyers.*	Smell, pollution of water.
Bacon, shops for smoking.	Smell, smoke.	*Earthenware*, manufacture of, with non-smoke-consuming furnaces.	Smoke.
Bark-beating places in towns.	Noise, dust.	*Enamel*, application of, to metals.	Smoke.
Bleaching of threads and tissues of flax, hemp, and cotton, by the alkaline chlorides (hypochlorites).	Smell, pollution of water.	*Enamelled Ware* with smoke-consuming furnaces.	Accidental smoke.
Breweries.	Smell.	*Enamels*, manufacture of, with non-smoke-consuming furnaces.	Smoke.
Brick-works, with non-smoke-consuming furnaces.	Smoke.	*Faïence*, manufacture of, with smoke-consuming furnaces.	Accidental smoke.
Button-makers and other stampers of metals by machinery.	Noise.	*Farina* factories.	Smell, pollution of water.
Candles, manufacture of.	Smell, danger of fire.	*Fattening* of poultry in towns, establishments for.	Smell.
Candles and other objects in wax and stearic acid.	Danger of fire.	*Felt Hats*, manufacture of.	Smell, dust.
Candles of paraffin and others of mineral origin, moulding of.	Smell, danger of fire.	*Fertilizers*, depôts of, matters coming from night-soil or offal, dried or disinfected, and in covered storehouses, in quantity less than 25,000 kilogrammes.	Smell.
Casting and rolling of lead, zinc, and copper.	Noise, smoke.	*Fire-wood* yards, in towns.	Injurious emanations, danger of fire.
Cheese, depots of, in towns.	Smell.	*Flints*, furnace for calcination of.	Smoke.
		Foundries for second melting.	Smoke.

Business.	Character of Nuisance.
Freezing Apparatus, with ammonia.	Smell.
Freezing Apparatus, with ether or other related and combustible liquids.	Danger of explosion and fire.
Gas, for lighting and heating, manufacture of, for private use.	Smell, danger of fire.
Gasometers for private use, not adjoining the manufactories.	Smell, danger of fire.
Gelatine for food, and gelatine from white skins and fresh skins, untanned, manufacture of.	Smell.
Gilding and silvering of metals.	Injurious emanations.
Glass-works (common, flint, and plate) with smoke-consuming furnaces.	Danger of fire.
Gold and *Silver Beaters*.	Noise.
Goldsmiths' Ashes, treatment of, by lead.	Metallic fumes.
Guano, depôts of, when the quantity exceeds 25,000 kilogrammes.	Smell.
Guano for sale at retail.	Smell.
Herring, smoking of.	Smell.
Hungary Leather, manufacture of.	Smell.
Japanned Plate and metals.	Smell, danger of fire.
Leather-beating, hammers for.	Noise, concussion.
Leather-dressing works.	Smell.
Lime-kilns, running not over a month a year.	Smoke, dust.
Litharge, manufacture of.	Injurious dust.
Massicot, manufacture of.	Injurious emanations.
Mills for grinding plaster, lime, flints, and puzzolana.	Dust.
Mineral Black, manufacture of, by crushing the residue of the distillation of bituminous schists.	Smell, dust.
Morocco Leather works.	Smell.
Nitrate of Iron, manufacture of, when the injurious vapors are absorbed or decomposed.	Injurious emanations.
Oiled Textures for packing, tissues, tarred cords, tarred papers, bitumenized pasteboard and tubes, worked with heat.	Smell, danger of fire.
Worked cold.	Smell.
Oils, refining of.	Smell, danger of fire.
Oil-works or oil-mills.	Smell, danger of fire.
Olives, preserving of.	Pollution of water.
Paper, manufacture of.	Danger of fire.
Paper Pulp, preparation of, from straw and other combustible matters.	Pollution of water.
Pasteboard-making.	Smell.
Pasteboard Snuff-boxes, manufacture of.	Smell, danger of fire.
Perchloride of Iron, manufacture of, by dissolving peroxide of iron.	Injurious emanations.
Plaster-kilns, not running more than one month a year.	Smoke, dust.
Porcelain, manufacture of, with smoke-consuming furnaces.	Accidental smoke.
Protosulphate of Iron or green vitriol, manufacture of, on a large scale, by the action of sulphuric acid on iron-filings.	Smoke, injurious emanations.
Puzzolana, artificial, furnace for.	Smoke.
Rags, depôts of.	Smell.
Red Cyanide of Potassium, or red prussiate of potash.	Injurious emanations.
Red Lead, manufacture of.	Injurious emanations.
Salt of Soda, manufacture of, with sulphate of soda.	Smoke, injurious emanations.
Salted Meats, depôts of, in towns.	Smell.
Salting and preparation of meat.	Smell.
Scalding-houses, for the preparation of parts of animals fit for food.	Smell.
Sealing-Wax, manufacture of.	Danger of fire.
Sheepskins, drying of.	Smell, dust.
Silvering of mirrors.	Injurious emanations.
Soap Factories.	Smell.
Spinning of cocoons, shops in which it is done on a large scale, *i. e.*, employing at least six spindles.	Smell, pollution of water.
Sponges, washing and drying of.	Smell, pollution of water.
Steel, manufacture of.	Smoke.
Sulphate of Iron, alumina and alum, manufacture of, by the washing of roasted pyritous and aluminous earths.	Smoke, pollution of water.
Sulphur, powdering and sifting of.	Dust, danger of fire.
Tan-mills.	Noise, dust.
Thrashing, carding and cleaning of wool, hair, and bed feathers.	Smell, dust.
Tile Works, with non-smoke-consuming furnaces.	Smoke.
Tinned Iron, manufacture of.	Fumes.
Tobacco-pipes, manufacture of, with smoke-consuming furnaces.	Accidental smoke.
Wadding, manufacture of.	Dust, danger of fire.
Wash-houses.	Pollution of water.
Waste of thready matters, depôts of, on a large scale, in towns.	Danger of fire.
Whalebone, manufacture of.	Unpleasant emanations.

Business.	Character of Nuisance.	Business.	Character of Nuisance.
White Lead, manufacture of.	Injurious emanations.	*Woollen Thread*, scraps and waste of spinnings of wool and silk in towns, special works for the beating and washing of.	Noise, dust.
Wire-drawing works.	Noise, smoke.	*Wool-washing* places.	Pollution of water.
Wood-charcoal, depôts of, in towns.	Danger of fire.	*Zinc-White*, manufacture of, by combustion of the metal.	Metallic fumes.
Wood-charcoal, manufacture of, in closed chambers, with combustion of the gaseous products of distillation.	Smell, smoke.		

For convenience in treatment I shall divide public nuisances into three classes, viz.: *Offensive Trades*, *Offensive Processes*, and *Other Nuisances* (including all nuisances of so heterogeneous a nature that they cannot be readily classified under a less general heading). Under each of these headings I shall classify nuisances according to the predominant offensive characteristic, *i. e.*, the chief quality on account of which they are looked upon as nuisances. Most of them can thus be brought under the headings of *smell*, *fumes*, *dust*, *smoke*, or *noise*. Under some of these headings, again, are further subdivisions where the mass of material seemed to require them. This system of classification gives rise to the following scheme of treatment:

I.—Offensive Trades.

Those businesses in which the substances dealt with are offensive, or may become so as a result of *mechanical manipulation*.

1. *Smell:*
   - *a.* Keeping of living animals: Horses, cattle, pigs, sheep, goats, poultry, fancy fowls and birds, rare animals, dogs.
   - *b.* Killing of animals: Cattle, pigs, sheep, calves, poultry, other animals.
   - *c.* Storage and handling of animal matters: Manure, offal, night-soil, bones, hides, fertilizers, hoofs and horns, cheese, fish, oil, eggs.
   - *d.* " " " " vegetable " : Fruits, vegetables, essential oils.
   - *e.* " " " " mineral " : Oils.
   - *f.* " " " " mixed " : Rags, kitchen refuse.

2. *Dust:* Sand-blast, carpet-cleaning, hair-picking, street-sweeping.

3. *Noise:* Street-vending, street-music, junk-dealing.

II.—Offensive Processes.

Those businesses in which the substances dealt with are offensive as a result of *chemical manipulation*.

1. *Smell:*
   - *a.* Manufacture of animal substances: Fat-rendering, lard-refining, soap-making, glycerine-refining, gut-cleaning, bone-boiling, tripe-boiling, blood-boiling, pork-packing, tanning, glue-making, shell-burning.
   - *b.* " " vegetable " : Brewing, gas-making, distilling, sugar-refining, vinegar-making, varnish-making.
   - *c.* " " mixed " : Cooking.
2. *Fumes:* Manufacture of chemicals, glass-works, potteries, bleaching-works, brick-making, smelting, refining, assaying, jewelry manufacture.
3. *Dust:* Plaster-burning, lime-burning, coffee-roasting.

III.—Other Nuisances.

1. *Smell:*
   - *a.* Dead bodies: Human (contagious), lower animals.
   - *b.* Gases of decomposition:
     - From privy-vaults.
     - " ventilating shafts and pipes.
     - " sewer openings.
     - " street-gutters.
2. *Infectiousness:* Cemeteries, prostitutes, diseased animals.
3. *Dangerousness:* Unprotected stairways and areas, buildings in course of erection, swinging signs, ferocious animals.
4. *Smoke:* Box-factories, planing-mills, foundries, forges, potteries, dye-houses, sugar-refineries, breweries, ordinary chimneys.
5. *Noise:* Railroads, factories, machine-shops, forges, boiler-works, steam-whistles, exhaust-pipes, bells, fireworks, paved streets.

This classification, like all others of the same character, is necessarily imperfect, for many of the businesses mentioned above are nuisances in more ways than one, and individuals might easily differ as to which of the bad qualities was the most objectionable. A thoroughly scientific classification will be found to be impossible.

I.—Offensive Trades.

Those businesses in which the substances dealt with are offensive, or may become so as a result of MECHANICAL *manipulation.*

The only subjects brought under this heading, which would not naturally fall under it according to the above definition, are those in the third division, viz.: *Street-vending*, *street-music*, and *junk-dealing*. As they are to be considered trades, however, and cannot well be placed under the other headings, they are put here, at the risk of some apparent incongruity.

1. *Trades which are objectionable on account of the unpleasant smells caused by them.*

a. *Keeping of Living Animals.*

Horses.—The keeping of horses is not likely to cause a nuisance in the country. The stables are generally at a considerable distance from the house, so that the odors from them are not perceived, and there is a con-

stant circulation of fresh air about them. Accordingly we find that, although the horses of the wealthy are housed in well-drained, well-ventilated stables, with proper facilities for the disposal of manure, the farm and village stables are carelessly built and kept. The drainage is often poor, and the wooden floor is cracked or imperfectly jointed, so that the urine runs through and soaks into the earth beneath. The manure is often thrown out of the window or door, and forms a large pile, on which other kinds of refuse are often dumped, so as to form a compost-heap. This may remain gradually accumulating, until spring or fall, when, having fermented meanwhile, it is spread over the fields.

In a thickly populated place the sanitary condition of stables is a matter of more importance. And even here too little attention is paid to drainage and the disposal of manure. The rich man's stable is often a horse-palace, the floors being of stone or hard wood, the drainage being as nearly perfect as possible, and the manure being removed daily or kept in such a situation as to be inoffensive. But the stables of a lower class leave much to be desired. They may consist of a mere wooden shed, in the rear of a tenement-house, with an imperfect wooden floor, through which the liquid filth passes and oozes out into the yard around the bottom of the building. The stable, being built in a confined space, is often badly ventilated, and this condition is rendered worse by the fact that the owners of horses are so afraid of thieves, that they do not construct windows of sufficient size. I have often seen cartmen's stables where the animals were only supplied with fresh air through the cracks and knot-holes in the sides of the shed. The manure is occasionally thrown into a heap in the yard, until enough has accumulated to make a cart-load, when it is removed. It is the rule, however, in New York, to put the manure in a covered vault or box, which is emptied as often as it gets full. There is great carelessness in the management of these boxes or vaults, and the cover is often left open day and night, when the vapors from the fermenting contents are very annoying to neighbors. Sometimes the greater part of a lot is occupied by small stable-sheds, placed side by side, only the central yard being paved and drained, and in such cases the nuisance is of course intensified.

The ground beneath the floors of these common stables is graded toward the yard, and all urine or water is supposed to run toward the central drain. But beneath wooden floors, and in uncemented or unpaved sub-spaces, rats are apt to make their nests, and the paths or "rat-runs" made by them are as likely to tend in one direction as another. They frequently extend toward the wall of an adjacent house, and may divert the current of urine in that direction. When this occurs, it is not generally long before a wet stain appears on the inner surface of the house wall, and the fluid may even work its way so as to run at times in a stream, and be a terrible nuisance.

The chief nuisance caused by a horse-stable is the smell, which, to many persons, is intensely disagreeable. This odor is due largely to ammonia, which is formed by the decomposition of the urine; but there are

also present in the air of stables undetermined organic matters, which give it its characteristic quality. The odor is quite pungent, and clings to porous fabrics with extreme pertinacity. One might endure the smell for a time, but to be followed persistently by it, after even a short exposure, is too much for the patience of most people. Hence, a stable has always been considered a nuisance when in immediate proximity to a dwelling.

While it is true that a certain degree of offensiveness is necessarily connected with a horse-stable, it is also true that the nuisance is much increased by certain preventable causes. These are, lack of cleanliness, deficient drainage, and bad construction of the stable with poor or unsuitable material, and insufficient ventilation. A stable where the manure is heaped up in the open air, exposed to wind and rain, where the space beneath the flooring is filthy with rotting straw and decomposing urine and manure, or where the drainage is deficient or obstructed, or the yard badly paved, so that pools of stagnant filth stand here and there in the sun, affords the greatest contrast possible to one where none of these bad conditions exist.

Lastly, the horses may make such an incessant noise with their stamping and neighing, especially in summer, when flies are about, that people living near by may be deprived of their sleep.

Of the effect of the emanations from horse-stables on the public health, little is known with certainty. It is a very common belief, especially with hostlers and stablemen generally, that exposure to the air of a stable benefits healthy persons and cures sick ones. The diseases which, it is claimed, are benefited in this way are pulmonary ones, and, so far as I am aware, no others. It is possible that the small amount of ammonia always present in such an atmosphere may act as a gentle local irritant to the respiratory mucous membrane, and in this way induce a healthier action when catarrh exists. The subject is perhaps worthy of investigation. I can suggest no other quality of stable air at all likely to be beneficial. It certainly cannot be of advantage to inhale hair, fragments of epithelium, scurf, ovules, fungi, and odorous organic matter, all of which Sigerson found in his examinations of such air. A number of physicians whose reports are published in the Report of the Council of Hygiene of the Citizens' Committee of New York, in 1866, gave it as their decided opinion that erysipelas and diphtheria were more prevalent and more fatal in the vicinity of badly-kept stables than elsewhere.

In order to render a horse-stable as slight a nuisance as possible, attention must be paid to ventilation, drainage, cleanliness, and the disposal of manure.

In a close stable, as in a close room filled with human beings, the peculiar animal odor is not only intensified, but becomes more offensive. This seems to indicate that the volatile nitrogenous compound (as it probably is) is of an unstable nature, and rapidly decomposes or in some way changes its qualities, under the influence of heat and moisture. There should therefore be abundant means for the access of fresh air and the re-

moval of foul, by doors, windows, and shafts, and there should be abundant air-space for each animal. Cameron says a horse requires 2,000 cubic feet of air-space and 100 square feet of floor area, and this is surely not a high estimate for an animal five or six times as large as a man.

The floor and drains are very important points. Flooring may be made of wood or of natural or artificial stone. The objection to wooden flooring is that it absorbs moisture, and so becomes saturated with urine, and can never be cleaned so that it will not emit an ammoniacal odor. The objection to stone flooring is that it is too good a conductor of heat, and a stable paved with it is apt to be chilly and uncomfortable for the horses. Moreover, in the city, where horses are employed on stone pavements during the day, it must be a relief to tread upon a warm, elastic wooden floor after their work is over. It would seem on the whole that a wooden floor is preferable, if carefully constructed. It should be made of a resinous pine, or of pine saturated artificially with oil or tar, so as to be non-absorbent, and the joints of the planks should be thoroughly caulked. The floor of the stalls themselves should be raised an inch or so, to allow of proper drainage, and along their rear should run a surface-drain, well made of cement, and discharging its contents into the manure-vault or into a sewer, preferably the former.

If a harder floor be desired it may be made of flag-stones, or square or oblong blocks of trap-rock, always laid in cement or concrete, so as to have perfectly tight joints. Flag-stones are liable to crack or break, or to become sunken at one side, and thus render the floor irregular, and cause trouble with the drainage. It is much better to lay the entire floor of cement or concrete, and bricks set on edge in cement may do very well. Ballard recommends, as the best flooring for horse-stables he has ever seen, a patent cement made by Wilkinson & Co., of Newcastle, consisting of Portland cement and roughly-ground stone or granite clippings run upon a basis of brick-bats. In any case the surface-drain for urine should be made of cement, so as to be jointless and impervious to moisture. Asphalt is too soft for such a purpose, and cobble-stones are difficult to clean.

In the country the stable-yard need not be paved; but in the city an unpaved yard soon becomes filthy with mire, churned up with urine and manure, and very offensive. A yard should be paved with brick or blocks of stone laid in cement. If there is a hydrant in the yard, and great cleanliness is observed, a pavement of cobble-stones laid in cement or concrete will answer, and horses do not slip on it. The surface of the yard should be graded towards a drain, which carries all surface liquids into the sewer.

If the wooden floor of the stable is not perfectly tight, the surface of the ground beneath should be cemented or concreted, and to render a nuisance from leakage impossible, any adjacent wall should be cemented to a height of at least eighteen inches. The cemented surface should be graded toward a surface-drain, which discharges all leakage from the floor above out into the yard.

Cleanliness is very necessary wherever animals are kept. With the exception of dogs and cats, who can be educated in this respect, domestic animals respond to the calls of nature wherever they happen to be. The manure and urine must therefore be frequently and thoroughly removed to some place remote enough from the stalls, so that the animals shall not be compelled to breathe an atmosphere contaminated by the products of decomposition.

The greatest danger connected with the compost-heap of country places is the pollution of wells and cisterns. This is more fully treated of elsewhere.

In populous localities the proper disposal of manure brings up some difficulties. Fermentative changes do not, as a rule, set in within twenty-four hours after the excreta leave the body, and, therefore, it is apparent that all nuisance due to them would be obviated by removing the manure daily. Daily removal, however, entails increased expense, and is difficult to enforce in a large city where there are some thousands of stables, unless the removal is undertaken by the municipal authorities. Moreover, the smell of the freshly deposited excreta is unpleasant, and frequently has to be controlled by disinfectants. In Germany, according to Layet, the perchloride of iron is sprinkled upon the mass. This not only disinfects it, but adds to the value of the manure. In France the phenol compounds and ammoniaco-magnesian phosphates are used for the same purpose; while the English avail themselves of the deodorizing properties of McDougall's powder, a mixture consisting principally of lime carbolate and magnesium hyposulphite. In New York the disinfectant in common use for this purpose is "dead oil," an impure carbolic acid.

If manure is allowed to accumulate on the premises, it must be stored so as to emit as little odor as possible. Ballard recommends that the atmosphere should have free access to all parts of the deposit, and that the liquid matters be drained away. The plan of removing the liquid parts undoubtedly renders fermentation more tardy, but it is open to a decided economical objection, viz., that the manure by this treatment loses its most valuable fertilizing properties, and its commercial value is diminished. In New York every stable is required by the Sanitary Code to have a manure-vault of not less than sixty-four cubic feet capacity, and provided with a tight cover. This receives both the manure and the urine. It should be lined with brick laid in cement, and may or may not be drained by a sewer connection. In the poorer class of stables, instead of an underground vault, a box is built above ground, of about the same capacity, and also fitted with a tight cover, which is always to be kept closed. In such cases the urine is drained into the yard, and thence into the sewer, excepting so much as may be taken up and retained by capillary attraction in the litter and manure. The offensiveness of horse-stables is considerably reduced by the use of these closed receptacles, and may be still further reduced by sprinkling the contents with very dilute sulphuric acid, which fixes the ammonia. The noise caused by the stamping and neighing of the horses cannot be controlled. If the walls are thick and properly dead-

ened, it will be somewhat reduced ; but, as a rule, no stable should be permitted so near a dwelling as to interfere with the sleep of the tenants.

Cattle.—Cattle are kept in stables or yards for domestic purposes, or to serve as food. In the former case any nuisance caused is a permanent one, in the latter a temporary one repeated at intervals. The former are mostly kept in the country, and the latter in or near the city, in the yards attached to slaughter-houses.

It is much more difficult to keep a cow-stable in a cleanly and inoffensive condition than a stable for horses, and this is principally on account of the semi-fluid character of the manure. In the country the filthy appearance of the cow-yard is familiar to most people. It is filled to a depth of several inches, or even a foot or more, with mud mingled with manure and urine, and in its centre is often a nasty pool of filthy water. The surface is scraped once or twice a year, and the scrapings spread over the fields. The horses and cattle are kept in the same barns, and the manure from the latter, so far as it is dropped in the stable, is thrown upon the compost-heap. The general construction of such a stable has already been described.

In the city, milch-cows are kept to some extent. Wealthy persons sometimes keep a single cow, and generally in an unobjectionable manner. In New York some of the poor people have two or three cows, and try to eke out a living by selling their milk. They are kept in low, close, badly-built sheds, with ill-drained yards, and are often badly crowded. They are fed largely on distillery mash, and are liable to be in poor health and to give an inferior quality of milk. The emanations from such stables are not always offensive, but the bad quality of the milk that comes from them is a constant source of detriment to the public health.

On the outskirts of large cities are often extensive yards, where hundreds of cows may be kept for the sake of their milk. These are kept in better condition than most of the small private stables, have well-paved and well-drained yards, and are frequently swept and washed. But, as land near a city is valuable, the animals are necessarily overcrowded, and they are also fed on distillery mash, or the residue of the grain after the brewer has got through with it.

Large sheds are connected with all abattoirs and slaughter-houses for the reception and maintenance of cattle before they are killed for food. They consist generally of large, low-roofed structures, with yards paved with wood, brick, or stone, and supplied with troughs for fodder. The yards are drained into the sewer, and washed daily.

The cow is emphatically an out-of-door animal. In the country she wanders through spacious pastures or chews her cud quietly in a large barn-yard or a roomy stall, and has good food and plenty of pure, fresh air. Little need be said on the construction of country barns in addition to what has been already written. The pollution of water is the thing most to be guarded against.

In the city the case is different. Cow-stables are necessarily crowded, and cows, according to Fleming, suffer from overcrowding much more

than men and the carnivorous animals do. The distillery grain upon which they are fed is believed by almost all scientific men to be an unwholesome and unnatural diet. In Europe it is charged with producing gastric troubles, and, if acid, as it frequently is, it is said to cause diarrhœa, enteritis, and, if long continued, a pruriginous affection of the posterior limbs. In Belgium it is looked upon as one cause of the contagious pleuropneumonia of cattle (Fleming). In New York and Brooklyn, cows have been found in the most frightful physical condition, with pustules and ulcerating sores on their teats and udders, with skin covered with scabs, tails rotted off to a stump, and sometimes suffering from internal organic disease, and apparently almost dying—miserable, half-starved creatures. And yet the thin, blue milk that could be squeezed from them was sold for food. Owing to the efforts of the New York and Brooklyn Boards of Health and the philozoïc energy of Mr. Henry Bergh, these effects of poor food, overcrowding, and bad ventilation are now happily rare.

Little is positively known of the effect of the emanations from cow-stables on the public health. I cannot forbear, therefore, giving a paragraph in full, which Dr. Ballard quotes from a previous report by Dr. Buchanan. He says: "The sanitary statistics of nearly six years were examined with reference to one particular cow-house, that is, in Stacey Street, which was so situated that its influence on health could be measured. The end of Stacey Street at which the cow-house is situated would be expected, *prima facie*, to have sanitary advantages over the other end which abuts on the middle of Dudley Street, a neighborhood unhealthy beyond most other parts of the parish of St. Giles. Now, on an analysis of the mortality, it was found that, three houses excepted, there had been an average of three deaths in each inhabited house, and in none a higher mortality than six in the six years. But in the three houses, Nos. 6, 7, and 9, there had been an average of 10 deaths each, viz.: in No. 6, 7 deaths, in No. 9, 9 deaths, and in No. 7, actually 14 deaths in the period under examination. Now, No. 7 is the house most directly connected with the cow-sheds; Nos. 6 and 9 are the two houses flanking it. No. 8 consists only of workshops, and the entrance to the cow-yard. In these three houses, Nos. 6, 7, and 9, 30 deaths occurred, while the other fourteen inhabited houses had only 40 deaths between them. The only two fever-deaths in the street were in these houses abutting on the cow-yard. Three out of the five deaths from diarrhœa were in them. Out of 10 deaths from acute lung disease which follow the zymotic deaths in their distribution and depend upon similar impurity of air, 8 occurred in these three houses."

In consideration of the facts that, with the present facilities for transportation, milk can be brought into the city from great distances; that city cows are always overcrowded and deprived of their natural light and exercise; that they cannot have their natural food of grass and herbage, and are almost always supplied with unwholesome and unnatural food; that they are dirty animals, and their stables are with difficulty kept clean, and

never can be as neat as a horse-stable—it is my opinion that cows should be entirely banished from every city, and only allowed under exceptional circumstances, when a wealthy man is able to afford a single animal the pasturage and freedom of motion which her health requires.

If cows are kept in the city, the stables should be constructed with the same care and regard for proper drainage and cleanliness as the stables for horses. A cow requires, according to Cameron, 1,500 cubic feet of air-space and 100 square feet of floor-space. They rarely get as much as this, for their keepers claim that if their stalls are large enough for them to turn in, they will strangle themselves with the halter. The cemented surface for drainage needs to be wider than in a horse-stable, on account of the semi-fluid droppings, which may often have to be swept along the drain. Ballard thinks that the best paving for cow-stables is made of asphalt or iron-stone brick laid in cement, or of cement alone. If these hard materials are used, the space near the head of the stalls must be left unpaved or covered with plank, for the cows are apt to bruise their knees on stone.

Manure should never be allowed to remain inside of the stable, as the vapors emanating from it add greatly to the impurities of the atmosphere. During the prevalence of pleuropneumonia among cattle in Islington in 1857, Dr. Ballard found that "while eight out of thirty-one sheds in which the manure was not stored within the shed had had cases of lung disease, as many as eight out of eleven in which the dung was stored within the shed had had cases of it. And as respects cattle-plague in 1865, I found generally that, while 66 per cent. of the sheds in which the manure was not stored within the shed were invaded by the disease, as many as 91 per cent. of those in which it was so stored were invaded." These figures are significant enough, though the storing of manure within the shed is itself indicative of crowded quarters, which may have had some effect on the prevalence of the disease, aside from the question of manure.

If distillery grain is used for food, great care must be taken to have it fresh. When acetous fermentation takes place, a very offensive smell is created, which extends to quite a distance from the stable, and gives rise to a veritable nuisance. It is also desirable to have the feeding-troughs made of stone or iron, so that they can be easily and thoroughly cleaned, as wooden ones are liable to become sour.

Cattle-sheds connected with slaughter-houses should always be paved with brick or stone well laid in cement. Many of those in New York are planked, but the incessant tread of so many feet wears the surface into splinters, and such a floor is always difficult to keep clean. The best pavement seems to be the Belgian, formed of trap-blocks five or six inches square, laid in cement. The yards should be well fenced in, as well as the approaches, to prevent the escape of cattle into the public streets—a caution very necessary in this country, where so many of the animals are brought from the Western plains, and are often unmanageable.

Pigs.—These animals are kept only for food. Excepting at the West, where they are allowed to roam about in herds and obtain food where

they can find it, they are kept in pretty close confinement. The pig is commonly supposed to be very filthy in his habits, and a pig-sty is proverbially nasty. As a rule this supposition is not belied by the facts. In country places, where only a few are kept at a time, the sty is cleaned only once a year or so, and there is often a mass of filth a foot deep spread over its bottom. The kitchen refuse, or swill, containing both animal and vegetable matter, is given them for food. The mess is often allowed to accumulate and undergo fermentation before it is used, and emits most nauseous odors. When the time for fattening arrives, to be sure, he is better fed, and spends the latter part of his life luxuriating on mush and molasses, or its equivalent. The wooden troughs in which the swill is poured become saturated with the fluids, and give forth a sour, disgusting smell. The hog-yards attached to the slaughter-houses in cities differ little from those already described as occupied by cattle.

Pig-stys are usually placed at a considerable distance from the dwelling, and are not in the country much of an annoyance. The odor, however, of large hog-yards in cities is peculiarly disgusting, and is sometimes carried by the wind to a considerable distance. Hog-yards may also constitute a nuisance on account of the incessant squealing of the animals. For both these reasons they should always be far removed from dwellings.

Hog-yards or piggeries, whether large or small, should be well paved, preferably with asphalt or cement. They should be graded so that fluids will not forms pools on the surface, and in the city the liquids may be drained into the sewer. The manure and dirt should be removed daily, and the yard washed. The feeding-troughs should be made of iron or stone, as they should for all animals that are fed on matters that are liable to ferment or putrefy. And if the pig be fed on good food instead of swill, be regularly groomed and washed, so that his skin is kept free from scurf, and is given a clean place to live and sleep in, the owner will be amply repaid for his trouble by the better quality and larger quantity of the pork.

Pigs should never be kept in thickly populated localities, for they constitute a nuisance with no compensating advantage. They are not allowed in the city of New York, excepting as kept by isolated squatters in the suburbs, and even then under constant supervision, and only when a written permit has been obtained from the Board of Health.

Sheep.—These animals are remarkably quiet and inoffensive, and rarely constitute a nuisance. In large stock-yards, where they are herded by hundreds or thousands, they cause some smell, but it is not of a penetrating quality, and does not travel far. Their excreta are easily removed, and are not offensive. Sheep-yards connected with slaughter-houses should be paved with asphalt or cement, and graded and drained as in other cases. A wooden floor, however, can be kept in pretty good condition as regards cleanliness and repair.

Goats.—Goats are kept for their milk, and are frequently found in cities. As they are not kept in large numbers, the hircine smell does not become very perceptible; and as they make little noise, are cleanly in their

habits, and make very little dirt, they rarely constitute a nuisance, excepting by their rapacity. They are hardy, energetic animals, very courageous, and disposed to be on familiar terms with mankind, and of a roving and inquisitive disposition. Moreover, they can live on the most frugal diet, and seize upon everything eatable they can find, from starched clothing down to kitchen refuse and brown paper. Their voracious habits render them public nuisances, often of the most aggravated kind. They should, therefore always be tied; but as they need considerable exercise, they may be allowed as much rope as possible without exposing the property of others to their depredations.

Poultry.—One who has only seen poultry kept in the country, where the only nuisance attributable to them is the scratching up of seeds, can hardly realize what a terrible nuisance they may cause in the city. Where many fowls are huddled together in contracted quarters, they keep up an incessant clucking and cackling, and the odor that rises from them is overpowering. In New York the Board of Health has carried on a struggle for some years, with occasional breathing-spells for both combatants, against the practice of keeping poultry for sale in the manner practised by the Polish and Russian Jews. On the plea that their religion requires them to eat only those fowls that have been killed in their sight by a killer authorized under their ritual, they fill the places where they live with chickens, turkeys, ducks, and geese. These poor fowls are huddled together in coops, or crowded into pens, generally in the basement of the house, and make an incessant noise. The smell, too, from fifty or a hundred geese, is indescribable and intolerable. And yet these people live in an adjoining room, and wonder that any person finds their practice obnoxious. The floor, of course, is soon covered with the excreta of the poultry, and, as the owners have always been used to living in filth, they would never think of cleaning the rooms, unless forced to do so by the sanitary authorities. As it is, all cleansing is done in the most perfunctory manner, and there is no real abatement of the nuisance from one year's end to the other. Of all fowls, geese are the most objectionable, both on account of their odor and noise. Chickens are often allowed to run loose about the yard. They are apt to dirty window-sills and railings, and in the morning wake the neighborhood at an unseasonable hour with crowing.

Poultry should not be allowed to be sold in the city outside of a properly-constructed market. They should be kept in spacious coops, with the bottoms well sprinkled with sawdust, which will absorb all moisture, and render the daily cleansing of the coops much easier than it otherwise would be. A trough should run along the outside of the slats, to hold water, and another for grain. If the corn is put in a vessel inside the coop, much of it will be wasted in the sawdust. The market should be well-ventilated, as the air of a place filled with poultry rapidly becomes close and offensive.

Fancy fowls and birds.—With the exception of mocking-birds, peacocks, and parrots, birds are not nuisances, unless they are gathered to-

gether in large numbers, as in the shops of dealers. Here they produce the same offensive odor which comes from poultry, and which is a source of great annoyance to neighbors. A considerable portion of the stock in such shops is always composed of parrots and mocking-birds, who keep up an incessant screaming and whistling, and are decidedly public nuisances.

The offensive odor from bird-shops cannot be entirely done away with, but it may be very much mitigated by cleanliness, good ventilation, and a free use of disinfectants. The cages should be cleaned once or twice a day, and their bottoms covered with sand or sawdust, or should be movable, so that they can be taken out and washed. If, in spite of all precautions, the smell and noise of such establishments are obnoxious to neighbors, it becomes the duty of sanitary officers to order their removal from the vicinity of dwellings, although in localities wholly given up to business they may be allowed to remain.

Sometimes a benevolent or astute individual puts a pigeon-house in the yard of his house, either stocking it himself or allowing the street pigeons to find their way thither. Where many pigeons are brought together in this way, they become an unmitigated nuisance by leaving their excreta on window-sills, clothes-lines, roofs, and railings. Where such collections are complained of, the pigeon-house should be removed, when the birds will disappear.

Parrots and peacocks are often kept as pets by private individuals. To nervous persons or invalids in the vicinity, these birds are often the cause of actual torture. It is not difficult to conceive that the health of some persons may be seriously impaired by the incessant chattering and shrieking of a parrot, or the discordant scream of the peacock. If such pets become a nuisance to others, they should be removed.

Rare animals.—The shops where these animals are sold are found only in cities or large towns. The smell arising from them is very composite, and can only be partially controlled by disinfectants. The odor of some beasts—the bear, for instance—is extremely penetrating and disagreeable, and shops for the sale of such animals should not be allowed in the neighborhood of dwelling-houses. Great regard must be paid to cleanliness, and disinfectants must be used freely. The cages of the larger animals have to be constructed so that they can be cleaned without opening them, and provision must be made for draining off the urine.

The noise coming from such places is often considerable, but cannot be controlled.

Dogs.—These animals are often kept by bird-fanciers, but many shops are devoted to the sale of dogs alone. The canine odor is an unpleasant one, even when the animal is kept scrupulously clean; and when several are kept together, the body smell, together with the odor of their excreta, is often quite overpowering. Dogs are also given to barking, and, where many of them are together, the noise is often incessant, even lasting through the night. The shops where they are kept have to be cleaned frequently and should be well ventilated. The floor should be sprinkled

thickly with sand, and disinfectants used in all the kennels. The dogs must be frequently washed, and, in fact, this part of their care is necessary to render them salable. In spite, however, of the best care, a dog-shop is always a nuisance, and should not be allowed excepting in parts of the town wholly given up to business.

Watch-dogs kept on private premises may become a nuisance on account of continual barking and howling. In cities, at least, such dogs should be removed.

Diseases and injuries due to attacks from these animals are considered elsewhere.

Recapitulation.

In brief, then, it may be said that the nuisance caused by the keeping of living animals may be brought under the following heads:

1. The odor caused by bodily emanations and the respiration.
2. The odor caused by the excreta.
3. The noise.
4. Pollution of wells and streams.

And the means applicable for abating these sources of nuisance are

1. Cleanliness, facilitated by a liberal use of water, and proper arrangements for drainage, including impervious flooring where the larger animals are kept, and the use of absorbent material, as sand or sawdust, for the smaller. Ventilation.
2. Prompt removal of excreta. Disinfection.
3. When necessary, removal from the vicinity of inhabited buildings.

b. *Killing of Animals.*

The business of slaughtering animals and preparing their flesh for consumption is an important and extensive one in every large city. Until comparatively recent times, every butcher killed animals on his own premises, when and how he chose, and from the lack of knowledge of sanitary requirements, from mistaken economy, and from carelessness, such places were always offensive and reeking with filth. Excepting where the utmost attention is paid to cleanliness, and unless special arrangements are made to secure it, there will always be adherent scraps of flesh and incrusted blood, which putrefy and fill the place with foul gases. The first important step toward remedying this condition of things was taken by the Emperor Napoleon the Great, who, by a decree of February 9, 1810, ordered the construction of large public slaughter-houses, called abattoirs, three on the right and two on the left bank of the Seine. These were completed and opened to butchers September 15, 1818, and have undergone alterations and additions since that time, in accordance with the growth of the city and the advance of sanitary knowledge. In these abattoirs all the butchers are compelled to rent spaces,

and no slaughtering is allowed outside of them. The buildings being constructed for the special purpose and provided with all necessary appliances, and at all times under government supervision, the nuisance inseparable from the trade is reduced to a minimum.

The example of Paris was followed elsewhere, and abattoirs are now found in many American cities, as well as in Europe. In London, private slaughter-houses are still permitted to exist, animals of considerable size being killed on the premises, in the rear of the shop where the meat is sold at retail, and even when families live in the upper part of the building. Many of these places are filthy and offensive, and cause great trouble to the medical officers of health. According to law, no slaughter-houses were to be allowed within the limits of the city after 1874, but when that year closed there were still twenty-eight licensed ones remaining. This affords a striking commentary on the difficulty of enforcing sanitary ordinances when they come in conflict with vested interests.

Previous to 1866 the slaughter-houses in New York were scattered about the city, as they are in London at present. Some of them were in populous localities, and even in immediate proximity to public schools. They constituted an evil of immense magnitude, and only after numerous checks and some defeats did the Board of Health bring them to the quite satisfactory condition in which they now are. They are now all situated on the river fronts, east of Second Avenue or west of Tenth Avenue, and north of Fortieth Street. New buildings have been erected, with approved methods of ventilation and drainage, by private enterprise. They are in effect abattoirs, being constantly under official supervision, although not erected at the public expense, and therefore bringing in no revenue to the city. Connected with them are immense stock-yards, and the numerous establishments for the disposal of the offal, blood, etc., which really form but an addition to or extension of the business.

Cattle.—There are three principal methods of killing beeves, all of which are subject to variations. In Europe it is the custom to kill them by concussion, either by the hammer, the pole-axe, or by means of a headpiece with a projecting pin on the under side, which pierces the skull when it is struck with a heavy mallet. In the latter case the eyes are shaded, so that the animal cannot see the falling blow, and this is considered to be a very merciful feature. In the West, where the wild cattle are often so unruly that killing in the ordinary way would occupy too much time, the animals are driven one by one under a platform, on which stands a man with a lance or carbine. With the weapon he strikes or shoots the creature just behind the horns, severing the spinal cord, and probably often destroying the functions of the medulla oblongata. Cattle killed by any of these methods have to be bled afterwards, and that very soon, for if the blood be allowed to coagulate in the flesh, the meat is spongy, of a purplish color, and readily decomposes.

In New York, the Jewish method of killing has been universally adopted. A few animals are separated from the herd in the yards, and driven into a small pen by themselves. Thence they are taken one by one

into the slaughter-house. A slip-noose is thrown around one of the hind legs, from which a rope passes over a pulley attached above. The animal is then immediately hauled up, head downward, until the fore-feet are off the ground. The head is turned until both horns and the nose touch the floor, so that the neck is well exposed and somewhat extended, and the killer passes a long, keen knife once or twice across the throat, severing all the tissues back to the spine. The floor of the building is so graded that the blood, as it escapes from the vessels, flows into a trough, whence it is afterward shovelled up into barrels and taken away to the refineries or fertilizer manufactories; or it may run through an opening in the floor, into a tank placed to receive it on the floor below.

This has sometimes been looked upon as a cruel method of killing cattle, but the animals do not struggle or show any signs of suffering until the convulsions of anæmia set in, when the brain is depleted of blood, and consciousness must have already vanished.

When the animal is dead, the head is severed from the body, the feet cut off, and the body skinned, disembowelled, and cut in halves. The intestines are separated from the mesentery and sent to the gut-cleaners; the fat is cut off and handed over to the renderers, the stomachs to the tripe-cleaners, the heads to the head-cleaners, and the hoofs to the manufacturers of neat's-foot oil and glue. All scraps that cannot be otherwise utilized are sent to the makers of artificial manures, and the hides are generally salted down in a mass on the premises, until sent to the tanner. The meat is hung up to cool, and is not usually removed by those who have bought it until the morning after it is killed.

The odor of a slaughter-house is to most persons very unpleasant, until custom has made it familiar. In a well-appointed abattoir there should be no smell perceptible, excepting while slaughtering is going on.

The odor is a very composite one—the vapors from the warm entrails and flesh mingling with the sickish smell of fresh, warm blood, and with the breath and bodily emanations of the cattle who are waiting for their turn. These odors, however, do not extend far from the building, and by themselves would hardly create a public nuisance. In badly-built or badly-kept slaughter-houses, where insufficient water is used and cleanliness is neglected, dried blood and scraps of flesh adhere to the walls or the floors where they have fallen, and after a few hours begin to putrefy. Then the most noisome gases are evolved, and may poison the atmosphere for some distance away. If the blood or bloody water from washing is allowed to run into the street-gutter, as has happened in many cases in former times, or if they are carried away from the building by a surface drain, it is impossible to prevent a terrible nuisance.

Even in the best-appointed abattoirs, the lowing and moaning of the cattle, the clatter of their hoofs upon the stones, the noises, not loud, but suggestive, connected with the act of killing, with the sights which it is almost impossible wholly to conceal, render a slaughter-house a public nuisance which is not to be tolerated in the vicinity of dwelling-houses.

There does not seem to be any good reason for supposing that the

slaughtering of animals is in any way detrimental to the public health, especially when carried on in a cleanly manner, so as to avoid the evolution of gases of putrefaction. Butchers are usually a robust, hearty class of men, who are said to possess a remarkable immunity from epidemic diseases. Dr. Ballard, in the elaborate report already referred to, makes the same statement, but he gives the evidence of some medical officers of health in England who have the contrary opinion. Dr. Spear, for instance, Medical Officer of Health for South Shields, says, "that in his experience, during the two years that he has held office, the houses where slaughtering is carried on have been chief foci of zymotic diseases, and that in tracing back outbreaks of such diseases in the town, he has, on more than one occasion, traced back the infections to these houses, and has been unable to trace it back farther." Dr. Carpenter, of Croydon, has satisfied himself that a slaughter-house may be the starting-point of an epidemic of scarlatina.

It is a well-known fact that medical students and physicians who are exposed to the air of a dissecting-room, or, in other words, who inhale the gases evolved from decomposing flesh, suffer from diarrhœa, and sometimes from headaches and anorexia. The diarrhœa in particular is of a very obstinate character, ceasing only when exposure ceases, and is apparently due to the elimination of noxious matters through the intestinal mucous membrane. It would be fair, therefore, to suppose that the atmosphere surrounding a badly-kept slaughter-house might be so contaminated by the effluvia therefrom as to produce mild gastro-enteric disorders in those who inhaled it constantly. I have no facts, however, bearing on the subject.

It is known that dead animal matter is easily tainted by contact with the products of decomposition. If the fresh meat is hung up to cool, therefore, in an atmosphere that is filled with septic matters, it may become, if not absolutely injurious, at least unsafe to be used as food. This is an additional reason for keeping the air of such places as pure and wholesome as possible.

The great danger, then, in a slaughter-house is, that animal matters will be retained in the floors and walls, and by putrefaction render the place offensive. This is to be prevented by rendering these parts of the structure impervious, and by the most thorough cleanliness. The floors of the abattoirs in France and England are of asphalt or concrete, and the buildings are often of stone. In Paris they are of iron and glass. In New York it has been found that asphalt makes too soft a pavement, and Ballard says it has always been a failure in England. In summer, particularly, it becomes altogether unsuited to the heavy tread of the animals and to the ill-usage to which it is subjected. Cement and concrete are better, and Ballard decidedly recommends the latter; but they have been found in this climate to crack after a time, and then it becomes difficult to clean them, and they require constant repair. A very good pavement is made of bricks laid on edge in cement, either having two courses of brick, or having a sub-layer of cement or concrete from four to six inches thick. This floor is common in New York, but brick is too absorbent to make a

thoroughly good floor. Most of our butchers prefer wood, and some of our best abattoirs are floored with this material. The wood used is Georgia pine, very resinous, laid in heavy planks, and thoroughly calked, like the deck of a ship. Such a floor seems to be thoroughly water-proof, and I have often seen the under surface, which had been whitewashed some time previously, without a stain or any indication that a drop of fluid had ever passed through it. These floors are graded toward the place where the killing is done, and the trough in the floor which catches the blood is so constructed that when the blood has been removed it can be opened into the sewer, and the water used for washing flushes both it and the sewer.

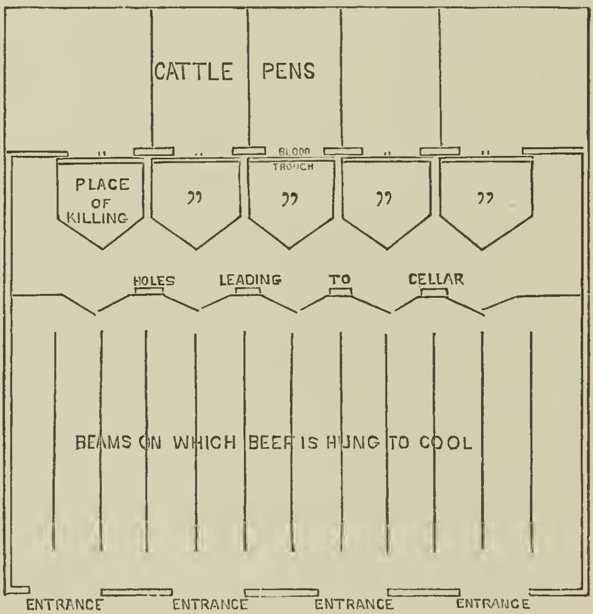

FIG. 1.—Plan of a slaughter-house.

It is well to have the sides of a slaughter-house lined for five or six feet from the bottom with the same impervious material which forms the floor, so that any splashes of blood or fragments of flesh or fat can be easily washed away. The building should be well ventilated, and it is a good thing to have the roof raised in the centre, and supported by louvre windows.

All of the blood, fat, offal, and refuse of every kind should be removed immediately. Section 58 of the Sanitary Code of New York requires that "all offal, blood, fat, garbage, refuse, and unwholesome or offensive matter be removed at least once in every twenty-four hours," and Section 59, "that no blood shall be allowed to remain therein over night." After everything valuable has thus been removed, the whole floor and parts of the walls that are exposed to dirt should be thoroughly cleansed. This requires a liberal supply of water, which is thrown about by a hose, while

men scrub the floor energetically with scrubbing brooms. Tardieu says that each of the Paris abattoirs requires a daily service of 90,000 litres of water. How much is used in a New York abattoir it is impossible to state, as we have no water-meters, and the supply is practically unlimited. If the cleaning is well done, and done every day, the atmosphere of an abattoir may be kept perfectly pure and sweet, in the intervals of killing.

The flooring must be kept in thorough repair. The severe blows required to sever the head of an ox from his body use up that part of the floor rapidly. If it is of concrete or asphalt, it gets broken, chipped, or indented, and is hard to clean properly. If it is of wood, it becomes, after a time, cut and splintered. Accordingly that part of the floor where the killing and cutting are done is covered with a second layer of heavy plank, which can be renewed when necessary without disturbing the floor itself. The ceiling and walls should be frequently whitewashed.

Pigs.—The smaller size of these animals, and the fact that the hide is not removed, but only stripped of its bristles, render a somewhat different arrangement necessary. While the slaughter-houses for cattle, sheep, and calves are one-story buildings, those for pigs have two stories, the upper one being used for killing and the lower one for dressing them. The reasons for this will appear farther on.

All the animals intended for killing on any particular day are gathered together on the upper floor of the building. This floor is divided into several pens, holding from ten to thirty pigs each, so as to render the isolation of certain animals easier. In one of these pens stand two men, who pass a slip-noose over the hind-legs of the pigs in rapid succession. As each one is caught thus he is raised and hung by a hook on an iron tramway, along which he is shoved by a single push, and brought immediately in front of the killer, who stands in another pen about six or eight feet away. He thrusts his narrow, double-edged knife into the neck, just below the sternum (the pig being head downward), turns it quickly upward, and divides the aorta. The dying animal is then passed along the tramway to another man, who stands about five feet away, and whose duty it is to loosen the animal as soon as he is dead, and let him drop through an opening in the floor into a vat of boiling-hot water on the floor below. After a short sojourn in this vat, he is hoisted by a single motion of a fork-shaped lever, upon a long bench with a considerable inclination downward, on both sides of which stand men with scrapers in their hands. They remove the bristles, which have been loosened by the hot water, and then the body is passed over to the men who remove the entrails, wash it, and put it aside to cool. The bristles are allowed to fall on the floor, whence they are gathered up and carried away by the brush-makers.

In England it is the general practice to remove the bristles by singeing, and various forms of apparatus have been invented for the purpose of doing this with expedition. According to Ballard, it takes about twenty-five seconds to singe a pig properly with the best arrangements therefor, and the odious smell of burnt hair is added to the other objectionable features of a slaughter-house. It is claimed, however, that the pork is

better, and that the rind acquires a flavor much liked by some people, and utterly lacking in the flesh of animals that have been scalded.

Latterly an attempt has been made to remove the bristles from the pigs by machinery. There is an ingenious arrangement of circular knives fastened to revolving belts, over which the carcase is rolled by two men, and almost entirely stripped of its bristles in an incredibly short space of time. This machine with two men does the work of six or eight, but is said to occasionally tear or cut the flesh in an unsightly manner.

The blood, offal, and trimmings of pigs are disposed of in the same way as those of cattle, excepting that the fat is sometimes rendered on the premises, instead of being taken away by other parties.

The nuisance caused by a pig-killing establishment differs from any other in important particulars. The odor of the hog-yards is more unpleasant and can be detected at a greater distance than that of cattle-yards, and the noise made by the animals is more acute and discordant. In the room where the killing is done there is a perfect pandemonium. In strong contrast to cattle, who may be seen chewing their cud while their companions are taken to the slaughter, pigs seem to have a premonition of their fate, and their squealing is so piercing and incessant that conversation, even in the loudest tones, is impossible. To the odor of blood and the body smell of the animals is added the steam from the scalding-vat, which fills a portion of the room with watery vapor.

What has been said of the construction and sanitary care of slaughter-houses under the head of cattle, applies with equal force to the establishments under consideration. The incessant and uncontrollable noise which accompanies pig-killing renders it more necessary to remove such places from the vicinity of dwellings than even the abattoirs for cattle.

Sheep.—The slaughtering of the smaller animals gives rise to less nuisance than those we have considered. Sheep are so entirely under the control of a man that no special apparatus is necessary for hoisting and holding them until they are dead. They are killed by cutting their throats, and are so placed as to bleed directly into a surface drain, which conducts the blood to a receptacle whence it can be readily collected and removed. The other details of dressing the meat, disposing of the offal, and the means for insuring cleanliness, do not differ essentially from those in the larger abattoirs.

Calves.—These animals are also easily managed by men, without the assistance of machinery. Their throats are cut, and the more thoroughly they are bled, the whiter and firmer the veal. They are more noisy than sheep, but not sufficiently so to constitute a serious nuisance.

Poultry.—The killing as well as the keeping of poultry may become a serious nuisance. In New York it already is so. In Bayard, Hester, Ludlow, and Essex Streets in particular, the nuisance has reached its highest development. The fowls are not only kept in and about dwelling-houses in crowded neighborhoods, but they are killed there. The killer, who is especially appointed for the purpose according to the Jewish ritual, makes his rounds on Thursdays and Fridays, and kills fowls in the

yard, as people purchase them. His apparatus consists of a barrel partly filled with sawdust, and a knife of peculiar shape and keen edge. The throats of the fowls are cut with a single stroke, and the birds are held head downward over the barrel, until their struggles cease. Very often the feathers are plucked on the premises, and where a hundred or more are killed and plucked, the yard, and the halls and rooms on the ground floor of the house, become smeared with blood and feathers, and present a most disgusting sight. After the killing is over for the day, the premises are washed and put in more presentable condition, but the bloody barrel often stands in the yard, and in summer may emit very offensive odors.

The nuisance in such cases is three-fold, viz.: noise, smell, dirt. The cackling of geese is incessant; and when killing is begun, as it often is, at five o'clock in the morning, sleep beyond that hour is impossible for all who live in the vicinity. The smell, as already described, is insupportable, and the filth caused by the excreta of the fowls, with the blood and feathers, is frightful.

Vigorous attempts have been made to suppress this nuisance by fines and imprisonment, but to no purpose. How it will finally be abated it is difficult to conjecture.

When only one or two fowls are killed at a time in a butcher's shop, or even in the kitchen or yard of a private house, no nuisance is created of a public character, and such cases do not require consideration. But when the killing of poultry becomes a business, and hundreds are slaughtered and dressed daily in one spot, special arrangements are required to prevent a nuisance. The best plan would be to have a poultry market, where all selling and killing of fowls by wholesale should be carried on. This market should have an asphalt or concrete floor, and the coops in which the fowls are kept should be arranged as heretofore described. If the building is in a thickly populated neighborhood, the walls should be deadened by a felt lining or an air-space, or in some other way, so as to render the noise less obnoxious. It should be well ventilated, and frequently whitewashed. The killing can be best done by cutting the throats of the fowls over a large trough filled with running water and sewer-connected. The blood of poultry is too small in quantity to be advantageously preserved for industrial purposes, and still plentiful enough to create a nuisance if not properly disposed of. Accordingly it should be run into the sewer, as above suggested. The trough should be lined with zinc, and should be at least two feet in diameter, to prevent blood from being splashed beyond the edge by the struggles of the dying bird. Its length, of course, must be proportioned to the amount of killing to be done at one time. At one end should be the overflow-pipe, connecting with the sewer, and at the other the water-supply. This arrangement will facilitate cleansing. Above the trough should be a line of hooks, on which the birds can be suspended over the water. Daily washing and cleaning are quite as necessary for such a market as for the larger establishments in which food-animals are slaughtered.

Other animals.—In European cities it is customary to have establish-

ments (called knackeries in England) where old, disabled, diseased or otherwise useless horses are killed and their carcasses disposed of. The dead bodies of other animals, when they cannot be used for food, are sent to the same works and there utilized. In New York animals are killed, generally by shooting, wherever they happen to be, and then the carcass is carried by boat to the private works on Barren Island. If a horse has farcy, or is injured so that recovery is impossible, or for any other reason is condemned to death, it seems both more humane and better for the community that he should be killed on the spot, than that he should be led or carried through the streets to a slaughter-house in the outskirts. Diseased cattle, sheep, and pigs are also killed and sent to the same place. Dogs and cats help to swell the numbers.

In large cities, dogs who have no master are generally looked upon as public nuisances. They are great thieves, and there is a certain amount of danger in allowing them to run loose. Stray dogs are therefore usually killed, and in New York, during the summer, official dog-catchers are appointed, who are allowed to capture every dog that is unmuzzled, or is not controlled by a string or chain in the hands of its owner. These men receive a small sum for them on their delivery at the pound, and here they are killed, after being kept a few days for reclamation. A large number of them at a time are put in an iron crate and dipped beneath the surface of the river. In this way thousands are drowned every year. It would seem more humane, though perhaps not so cheap, to put them in a tight compartment, and drown them with carbonic acid gas.

The dead bodies are carted to the offal dock and thence taken to Barren Island.

In European knackeries the flesh of horses, when suitable, is dressed for the market and sold as food. In this country the whole animal is utilized for industrial purposes. The skin, when fit for leather, goes to the tanners or leather-dressers; inferior skins, with hoofs, etc., go to the glue-maker; the bones are either cleaned and bleached, and used for buttons or knife-handles, or in the manufacture of phosphorus; or, more commonly, the whole animal is converted into artificial manure.

The precautions to be observed in the conduct of such establishments are those which are necessary in any slaughter-house. But in knackeries many of the carcasses received are in a state of decomposition and very offensive. This renders it necessary to remove such establishments to a great distance from inhabited dwellings.

Recapitulation.

Slaughter-houses then become nuisances:

1. On account of the noise of the animals.
2. On account of the odor from them.
3. From blood and other animal matters which may be retained in the walls and flooring, and there putrefy.
4. From the retention of offal on the premises until it becomes offensive.

Therefore:

1. They should be removed from the vicinity of dwelling-houses.
2. They should be provided with impervious flooring and walls and proper drainage, and thoroughly cleansed daily.
3. The offal and blood should be removed immediately.

c. *Storage and Handling of Animal Matters.*

Under the influence of warmth and moisture, animal substances rapidly putrefy, and exceedingly offensive gases are evolved. Some of these gases are capable of extensive diffusion, and can be detected by the sense of smell at a great distance from their source. It is the evident duty of public officials to prevent the formation of these gases as far as possible, and, in cases where this is impracticable, to control their diffusion so far as lies in their power, and render the nuisance caused by them a local one.

Manure.—The nuisance caused by the manure of stables can never be wholly done away with. A stable is a necessary evil, and it is almost impossible to prevent the accumulation of manure in connection with it. Where such an accumulation is a large one, and is allowed to remain for a considerable time before removal, fermentation takes place, and when the mass is finally taken away, a greater nuisance is created than if it had been removed when fresh. Such accumulations not only pollute the atmosphere in their vicinity, but the gases from them may pass through a wall and enter an adjacent building. I have myself observed a strong odor from a stable on the other side of a brick wall a foot thick, when there was no evidence of any hole or channel for the passage of the smell, excepting the porosities of the brick and mortar. Where such a nuisance exists, the outer surface of the wall must be cemented, and so made both air- and water-tight. In some cases, when the manure is kept in a vault, a ventilating-shaft extending above the roofs of the adjoining buildings will prevent, to some extent, the lateral diffusion of the odors.

The removal of manure will inevitably cause more or less nuisance. In many cases it must be carried in baskets or wheelbarrows across the sidewalk and emptied into the cart as it stands in the street. This must be the case where the stable is in the rear, and there is no approach to it sufficiently wide for a wagon. When the manure-vault is under the sidewalk, the contents have to be thrown with pitchforks several feet to reach the cart. The consequence of all this is that the sidewalk is strewn with manure, to the great disgust and annoyance of passers-by and neighbors. If the vault is not drained, and the manure is therefore moist or even partly liquid, of course the nuisance is still worse. And if the cart is not a tight one, and is not tightly covered, the liquid drips and the loose material on the top is shaken off all along the route, forming an unsightly and intolerable public nuisance.

Manure may be taken directly from the stables to the fields and spread upon them, or it may be dumped on vacant ground in a mass, and left there to ferment. In the latter case, if the mass is frequently turned and

dug over, and is sprinkled with lime, it becomes more valuable as a fertilizer. But the smell from such dumps is almost intolerable, and they form a public nuisance of the worst character.

The nuisance caused by the accumulation of manure in stables is to be controlled by the methods already mentioned, viz., the cementing of adjacent walls, disinfection of the mass, and ventilation of the vault. As the mass may be removed in such a way as to create a nuisance, the removal should be regulated by law, strictly enforced. According to the Sanitary Code of New York, such removal is not allowed between the hours of 10 A.M. and 6 P.M. without the permission of the Board of Health. It does not seem to me that this limitation is sufficient. As the loading and transportation of manure is somewhat of a nuisance, no matter how well conducted, it should only be allowed during hours when it is the least likely to cause annoyance. These hours are certainly the time when most people are indoors, and the business ought to be confined to the hours between one and eight o'clock A.M. The carts should be water-tight, and should have tight covers, so as to retain their contents so far as possible, whether solid, liquid, or gaseous.

Manure dumps cannot be conducted in such a manner as to be inoffensive, and should therefore only be allowed at a great distance from inhabited dwellings.

Offal.—If the refuse of animals that have been killed for food is immediately removed, as it should be, there will be no nuisance due to it on the premises where it is produced. It is always best to have it taken to the proper establishments and thoroughly disposed of, if possible, while it is still fresh. Besides the offal of slaughter-houses, however, there are the scraps and trimmings of meat collected by retail butchers. Although these should be removed daily, they are not always taken away before they have become a little tainted. Besides the danger of infecting the salable meat with septic matter, such retention is apt to create a nuisance to neighbors.

The scraps of fat and flesh from domestic and public kitchens also are sometimes kept on the premises until putrefaction has begun. In all these cases the offal is likely to cause a nuisance, not only where it is kept, but along the line of transit when it is removed.

Offal which has become offensive should be transported in tight carts, with close covers, or better still, the stuff should be placed in tightly-covered vessels on the premises, and then carried out to the cart. When it arrives at its destination, whether fertilizer manufactory, fat-rendering establishment, or soap factory, it should be kept unopened until it is to be used, unless the factory is so far from dwellings that no odors could be detected in any event.

The carts and vessels used for the transportation should be frequently cleaned and disinfected.

Night-soil.—The removal of night-soil from privy-vaults, if not properly regulated, may cause an intolerable nuisance. The stirring of the contents of the vault sets free very offensive gases in enormous quantity,

and although the work always used to be done at night, so as to avoid offence to the eye, the odor was often sufficient to wake those who were sleeping near by. Of late years, by the liberal use of disinfectants and of improved pneumatic machinery, this nuisance has been reduced to a minimum.

The contents of the vault should be thoroughly disinfected before removal. This is usually done by pouring in a mixture of dead oil and copperas (impure carbolic acid and protosulphate of iron). The New York Disinfecting Corps use half a gallon of the dead oil (containing fifteen per cent. of carbolic acid) and a gallon of a saturated solution of copperas, for an ordinary privy-vault. More may be required in one case than in another, and enough should be on hand for all emergencies, say, at least six or eight gallons. After disinfection, the night-soil may be removed in tubs or by pneumatic suction. If tubs are used, they should be water-tight, and have tightly-fitting covers, which are fastened down when the tubs are full. The full tubs may then be taken away in a cart without offence. By far the best method of emptying privy-vaults is pneumatic suction. A large tank on wheels stands in the street, and from this a strong hose passes back into the privy-vault. Then, by means of a pump connected with the tank, the contents are gradually sucked into it, while the air and offensive gases that are gradually expelled are passed through a charcoal fire or mingled with hot steam, and destroyed. In New York the privy-vault is not only a receptacle for night-soil, urine, and even slops, but many tenants empty ashes and garbage into it, or use it as a convenient dumping-place for old shoes, hats, hoop-skirts, etc. The consequence of this is that the pneumatic apparatus does not clean the vault perfectly, and there is always a composite mass of stuff at the bottom which cannot pass through the hose, and has to be taken out in tubs.

The tubs or tanks should be removed from the vicinity of dwellings before they are opened and emptied. Their contents may be either used immediately as manure, or more commonly they are manufactured into poudrette or superphosphates.

Bones.—An accumulation of bones from which the fatty matters have not been removed very soon becomes offensive. After a short exposure to the air the oil oozes out upon the surface, particularly in warm weather, giving them a translucent appearance. These oily matters are soon decomposed, and butyric, capric, and caprylic acids are formed. If the bones have not been thoroughly stripped of flesh, the ordinary gases of putrefaction are added to these ill-smelling acids. The result is a combination of the most disgusting odors that can be imagined.

The only such collections of bones that are found near dwellings, so far as I know, are those made by rag-pickers. In their general search through the garbage-receptacles, they appropriate not only rags and paper, but bones, throwing everything into their bags together. When they get home, the bones are picked over and sorted, and kept on the premises until called for by the dealers in such things. When it is considered that these bones have often been kept in kitchens until they were slightly

offensive, have then lain in the garbage-box for some hours—perhaps under a broiling sun—are carried about on a man's back for some hours more, and then remain in his room, or on some part of the premises where he lives, for a day or so longer, their condition at the end of that time may be imagined. No odor is to me more disgusting than that of such a place.

The smell from such accumulations may be somewhat diminished if the bones are kept in tight vessels until removed. But the odor diffuses itself widely, and is too penetrating to be entirely confined in this way. Ballard says that the nuisance may be prevented or very much mitigated by storing them in tarred bags, or covering them with a tarpaulin. I have had no experience with these expedients, and am inclined to doubt their efficacy. I do not think the storage of green or fresh bones should be tolerated in the neighborhood of inhabited buildings, as the disinfectants, which would be likely to considerably abate the nuisance, such as salicylic acid, are too expensive to make it worth while to use them.

Hides.—Green or fresh hides rapidly become offensive, especially if, as is often the case, scraps of flesh adhere to them. They are usually salted down in layers on the premises as soon as they are removed from the animals, and if the salting is thoroughly done, there will be no nuisance. The dried hides, which are brought in large quantities from South America and Texas, have a peculiar odor, and when many of them are stored together, it is decidedly disagreeable. As a rule, hides of any description should be stored only in the business part of a town.

Fertilizers.—The different varieties of artificial manure have their special odors, which are sometimes pretty strong, but to many people are not unpleasant. Guano has a very pungent and diffusive odor, which is not liked by most people. These materials are not kept in large quantities, excepting in the business parts of cities and towns.

Hoofs and horns.—The hoofs, horns, and tails of South American and Texas cattle come to the northern cities for sale to the manufacturers of combs, knife-handles, glue, and brushes. Although they come in a perfectly dry state, and have been carefully cleaned before they were shipped, they have a very unpleasant odor, and the places where they are stored are occasionally complained of to the Board of Health. Occasionally horns are sent on from the West which have not been "sloughed," *i. e.*, of which the core has not been removed, and they arrive here in a frightfully offensive condition, putrid, and covered with maggots. The "sloughing" of such horns is an exceedingly offensive process, and should not be allowed within city limits.

The storage of commercial hoofs and horns may be allowed in the business portion of a town, but not elsewhere.

Cheese.—When stored in large quantity, cheese may be very offensive, especially the German and some of the Dutch cheeses, which are far advanced in decomposition before they are considered fit for the table. The odor is caused partly by the fatty acids developed in them, partly by ammoniacal compounds, and partly by the decomposition of the casein.

The nuisance due to such merchandise cannot be entirely abated, but may be mitigated to some extent by keeping the most offensive kinds of cheese, such as Limburger, Handkäse, Kuhkäse, and sago cheese, in a cold place, as the sub-cellar, or, better still, in a refrigerator. If the cellar is used, it should be made as tight as possible, and ventilated by two shafts of unequal height running above the roof of the building. The odor is one to which people soon become accustomed, and those who enjoy eating such cheese do not usually object to having it stored near them. But if neighbors complain, the storage of such cheese should not be allowed in the vicinity of dwellings.

Fish.—The smell of fish is to most people very offensive, and it clings to the clothing with great pertinacity. Moreover, the scales and the slimy substance on the outside of the body come off and adhere to everything with which they come in contact, and rapidly become putrescent. Decaying fish give off large amounts of ammonia, and are peculiarly offensive on account of the evolution of phosphoretted hydrogen. The nuisance created by a fish-market cannot be entirely done away with, but strict cleanliness and frequent washing of all exposed parts of the building are absolutely necessary to render the place even tolerable. The slabs on which the fish are exposed, and the floors and walls of the shops, are best made of stone laid in cement, so that the joints are perfectly tight. The floor should be well graded and drained into the sewer, and after the day's business is over everything should be thoroughly washed and scrubbed, and all offal removed.

Oils do not give forth much odor if they are put in tight barrels, but, in the bustle and careless handling of railroads and truckmen, leaks are often started, and it is rare to see a cellar filled with barrels of oil whose floor is not covered with grease. The most offensive oil of all, and that which gives rise to the most frequent complaints, is the "grease," as it is called, made from refuse pork-trimmings, which have become putrescent before they are rendered. This "grease" has a certain amount of the crystallizable fats in it, stearine and palmitine, and some of it at ordinary temperatures is semi-fluid. This stuff, being very cheap, is often carelessly packed, and the barrels are very apt to leak. Moreover, there are certain houses, where the contents of those barrels which contain the better qualities of this substance are put in muslin bags between iron plates, and subjected to a continuous pressure by a weighted lever, to squeeze out the fluid portion. With the olein go the offensive portions of the stuff, and what is left in the bags forms a beautiful, white, hard cake, chiefly stearin, which is used for making candles. The residue is repacked and used for making axle-grease or the inferior qualities of soap. These establishments are always somewhat offensive, but the odor does not extend far, and while it should prevent their location near dwellings, is not enough to compel their removal from the business or manufacturing portions of a town.

The only remedies for the nuisance caused by the odor of oil are tight packages and cleanliness.

Eggs.—Among articles of commerce that, under certain conditions, may become very offensive, are eggs. When they are dealt in by wholesale and thousands of them are stored in a cellar, they have to be frequently picked over—"candled," as it is called—in order to throw out the rotten ones, of which in summer there is a considerable proportion. The odor arising from this cause, mainly due to sulphuretted hydrogen, may be abated by sprinkling the offensive eggs freely with chloride of lime, the free chlorine of which seizes on the hydrogen of the offensive gas with great avidity. The rotten mass should be removed often, and the place frequently and thoroughly cleaned.

d. *Storage and Handling of Vegetable Matters.*

Fruits.—The storage of fruits is never likely to cause a nuisance unless they are decayed, although the odor of oranges and lemons in large quantities is not always pleasant. Decayed fruit is sometimes exceedingly offensive, and the dealers in such articles are often so careless about its removal that complaints from this cause are not seldom received by the sanitary authorities. The only remedy, of course, is the instant removal of the offending matters, and the thorough cleansing of the place where they have been kept.

Vegetables.—Some kinds of vegetables, as leeks, garlic, onions, and turnips, when collected in large quantities, may constitute quite a serious nuisance. The essential oils to which the first three owe their peculiar odor are very volatile, and to most people exceedingly disagreeable. Many other vegetables, as potatoes, and especially cabbages, become offensive by decay. All vegetables are generally kept in cellars, as they require a cool place for their preservation, and such cellars should always be in the business part of the town, and their contents frequently sorted, and all decaying matter removed. It is best, if possible, for storing the more offensive vegetables, to have the cellar tight and ventilated by special shafts, as recommended for cheese warehouses.

Although I have no positive evidence to offer on this point, there are many well-known facts which indicate that the emanations from decaying vegetable matter may be injurious to health.

The poison, whatever its intimate nature, that gives rise to the malarial fevers, is probably evolved in some way from decomposing vegetable matter. Decaying vegetables furnish an appropriate nidus for several varieties of fungus, and their spores, often invisible to the unassisted sight, float in the atmosphere and are inhaled with every breath we draw. It is in the late summer and autumn, when fields are ripening and the forests and meadows are filled with decaying vegetable matter and with fungi that are sending forth clouds of microscopic spores, that hay fever is prevalent. Whatever the effect of such accumulations may be, it is certainly safer to remove them as zealously and thoroughly as putrescent animal matter is removed, although their odor is not quite as offensive.

Essential oils.—The various oils and essences used in the manufacture

of perfumes, together with turpentine and its derivatives, and the resins and balsams, are principally stored in large cities. They are all volatile at a low temperature, and while the smell they create is not usually unpleasant enough to call for its suppression, it is so sometimes. I have known of dizziness and headache being caused by the odor of the oil of cloves in persons who had their office immediately over the place in which it was stored. The smell seems to be rapidly dissipated in the outer air, and if a whole building is occupied by the business, I do not think the neighbors would be incommoded by it, excepting under unusual circumstances.

The greatest nuisance caused by the storage of essential oils is undoubtedly the danger of fire. This is to be guarded against by storing them only in fire-proof buildings.

e. *Storage and Handling of Mineral Matters.*

Oils.—The only mineral substances likely to cause a nuisance are the petroleum oils and the derivatives of coal-tar, including all the varieties of naphtha and the different burning fluids. The storage of these in large quantities not only offends the sense of smell, but exposes the neighborhood to the danger of fire. The odor cannot be entirely done away with, but it may be mitigated by cleanliness and attention to the condition of the barrels, which should always be, and generally are, perfectly tight, more attention being given to their proper packing than to that of the animal and vegetable oils, on account of their great inflammability.

For the protection of the community, no petroleum or kerosene oil is allowed to be sold or stored in New York City with a flashing-point—*i. e.*, a temperature at which inflammable vapors are given off—less than 100° Fahrenheit. In France the flashing-point is fixed by law at 35° Centigrade, or 95° Fahrenheit, a temperature not seldom reached in this country by the external atmosphere on a summer day. All such oils should only be stored, in large quantities, in fire-proof structures. It is better if these buildings, besides being fire-proof, are only one story high. It has been suggested in France that petroleum should be stowed in large inverted vessels floating on the surface of water, like gasometers, so that the access of flame would be impossible. Another plan is to sink the barrels in water, and keep them there by weights until wanted.

f. *Storage and Handling of Mixed Matters.*

Rags.—The collection of and commerce in rags for the manufacture of paper is an extensive industry. In all large cities, among the lowest class of the population, are the people called rag-pickers or chiffoniers. They go about with a bag and hook and gather up whatever they think they can dispose of, wherever they can find it—scraps of paper and pasteboard, rags, bones, old shoes, glass, etc. The bone nuisance has already been spoken of, and the only other offensive part of their business is the sort-

ing and washing of rags. As they are picked up from the street-mud, from garbage-boxes, and heaps of kitchen refuse, and so are often filthy in the extreme, they have to be carefully picked over and washed. This is done in the yards of the houses inhabited by this class of people. Every morning they may be seen, men, women, and children, busily engaged in this work, and every afternoon, every available space in the yard, the outbuildings, the sides of the houses, the balconies, and fire-escapes, are covered with wet rags of all colors and sizes drying in the sun. This process gives rise to a peculiar stale, musty odor, which is somewhat unpleasant to those who live near by; but it is difficult to see how it can be prevented. The collection of rags is a very important and necessary industry, and the persons engaged in it are too poor to afford great warehouses or drying-houses for the purpose. The only remedy that would be of any avail would seem to be to banish them to a particular quarter of the town, and not allow them to prosecute their business elsewhere.

The rags, after sorting and washing, are sold to dealers, who pack them in bales, covered with coarse matting or canvas, and fastened with rope or iron bands. In this condition vast cargoes of rags yearly arrive in this country from Europe, where the demand for paper-rags seems to be less than it is here. Imported rags are said to be disinfected before they are packed abroad, and they are not allowed to be landed without a permit from the Board of Health. If any bales are broken during the passage, and need repacking, they should be disinfected, as they are often collected and sent from ports where contagious diseases are epidemic. The bales, whether domestic or imported, are sent, as a rule, direct to the paper-makers as received.

The storage of rags in bales rarely gives rise to a nuisance, unless some of the bales happen to be wet during their transit. They then exhale the musty odor spoken of above. So far as I know, the nuisance is never of a character or importance to require interference by the authorities. It might be presumed that substances collected in such a reckless and indiscriminate way as rags would be a common means of propagating contagious disease, but I have never heard of, or seen a case in which this occurred, nor have I been able to find any account of one in my reading.

Kitchen refuse.—The leavings of the table and the kitchen, consisting as they do of matters that readily ferment or putrefy, very soon become offensive, if they are not in some way disposed of. In country households the fatty portions, bacon- and pork-rinds, rancid butter and lard, lumps of tallow, etc., are saved to make soap with, while the bones and scraps of meat feed the dog and cat, and the vegetable refuse goes to the swine. But in cities the disposal of this stuff is a matter of some difficulty. In large hotels much the same plan is followed as in the country, *i. e.*, the fat is taken by the soap manufacturers, the bones and meat by the manufacturers of fertilizers, and the vegetables are taken away by farmers, who call for them regularly. But the refuse of private houses and of tenements is so mixed that it is of no use to any of these persons. The lower classes in New York mingle their ashes and garbage

even, and cannot be taught to separate them. The vegetable matters soon undergo an acetous fermentation, especially if there is much fluid mingled with them, and the animal matters putrefy, making the mess so offensive that it cannot be kept in the house. It is then taken out into the street, and there becomes a nuisance of a grave character.

This nuisance is one that never can be fully abated. In cities where alleys or narrow streets run in the rear of all houses, the removal of this refuse can be accomplished through the back door, and the street nuisance thus be prevented entirely. But in most cities the stuff must be collected from the street in front of the house. In Paris it is the custom to throw it into the street-gutter in the evening, whence it should be and often is removed early in the morning. In New York it is put in boxes or barrels, and left on the sidewalk until called for, often remaining there for two or three days. Before many tenement-houses are large, stationary garbage-boxes, which receive the refuse of twenty or thirty families, and sometimes twice as many. If these are not frequently emptied, their contents overflow on the sidewalk and gutter, and create a horrible nuisance.

It has been suggested in New York to have receptacles of metal sunk in the sidewalk in front of each house, to receive the household refuse, the tops of them to be flush with the pavement, and covered with metal covers, like those now used for coal-slides. These receptacles are intended to be taken up, emptied, and then returned to their places. An evident objection to them is that in winter the contents would freeze, rendering it difficult, if not impossible, to remove them; and if they were overfilled, the covers being raised would form an obstruction to street travel.

The only relief that can be afforded is that obtained when the refuse is removed promptly, frequently, and at hours when most people are asleep. Probably the least annoyance would be caused if the barrels and boxes were put out on the street daily, late at night, emptied before seven o'clock in the morning, and taken in again before eight. It is stated by Götel that, in Lyons and Bordeaux, the household refuse is put at once into the vessels in which it is to be removed to the dumps outside of the city. I cannot see how this can be done in a large city, and Götel does not give the details. The fact that it is not done in Paris seems to indicate that the plan is only practicable in smaller towns.

The occupants of tenement-houses sometimes create a nuisance to people in adjoining buildings by throwing refuse out of the rear windows into the neighboring yards, to save themselves the trouble of carrying it down to the street. In such cases it has been the practice of the New York Board of Health to order the windows whence the stuff is thrown to be covered with wire-netting.

2. *Trades that are offensive on account of the dust caused by them.*

As a rule, the dust evolved in the prosecution of any business affects only those who work on the immediate premises; but a few occupations give rise to such an immense quantity, that much of it escapes into other

premises and often causes a serious nuisance. The escaping dust is diluted by the air and rapidly settles, so that the direct injury to health of persons outside the place where it is produced is probably trifling. But such dust settling on furniture, clothing, and food, makes everything so dirty as to seriously interfere with comfort, and often obliges people to keep their windows and doors shut to keep it out, a step which may prevent proper ventilation of dwellings, and thus, particularly in hot weather, indirectly compromise the health.

Sand-blast.—The use of sand for glass-grinding or etching is one of the great industrial improvements of the century. The sand is driven by a powerful blower against the surface to be ground, the portions of the glass which are to remain unaffected being covered with a thin coating of wax and tin-foil. After a few moments' exposure to the sand-blast, the unprotected surface is beautifully and evenly ground without further manipulation. The tremendous force of the air-current which carries the sand renders it impossible to retain it in any way, and the dust, composed of fine sand and glass, flies out into the room, and unless some means be provided for its escape soon renders the place untenantable. The windows have to be kept open, and much of the dust escapes into the outer air, while some of it settles on the floor.

Attempts have been made to confine the dust in a shaft and blow it into a water-tank, in the hope that it would become wet and settle. But the pressure of air is so great that it forces its way out of the minutest cracks, even between the rubber rollers through which the sheet of glass is introduced into the current, and, as I have myself seen, the dust may be blown fairly into water, and a certain portion of it, nevertheless, rise into the air. In a case where the dust from a sand-blast injured the delicate machinery of a card factory about one hundred feet distant, so that the windows had to be kept closed where hundreds of operatives were at work, the Board of Health found themselves obliged to compel the removal of the business to a more suitable locality.

As it does not seem practicable to confine or fix the dust of such establishments, they should be removed to the outskirts of cities and towns, or to some place where the dust will do no harm, as in the vicinity of lumber-yards, forges, etc. The dust will not be perceived at a distance of three hundred feet sufficiently to be a nuisance.

Carpet-cleaning.—The removal of dirt from carpets by beating them gives rise to a two-fold nuisance, noise and dust. In Paris, after the classification of nuisances previously given, the carpet-beaters were all removed from the quartier St. Avoye, and afterward from the place they had taken under the Pont Neuf, on account of the noise, dust, and depreciation of property attributed to their occupation. The obnoxiousness of this trade may be considerably lessened by suitable machinery. At one place in New York the nuisance seems to be reduced to a minimum (Fig. 2). The ends of the carpet are pinned together so that it constitutes an endless chain, which rests upon a rubber platform, plush surface downward, being drawn along by two rollers, between which it passes.

As it moves it is beaten by rods, and the heavier dust falls into a long piece of sacking stretched beneath it; the lighter dust, which would otherwise float out into the room, is drawn upward into a large hood which covers the whole machine, and thence into a flue by a powerful

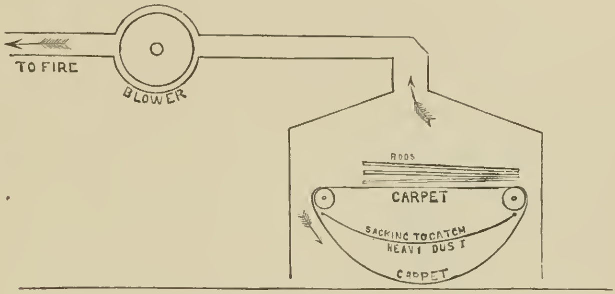

Fig. 2.—Carpet-cleaning machine.

blower, which sends it forward into a lofty chimney. As it is forced out of the top of this chimney, it quickly becomes so diluted by the atmosphere, and is so borne away by the winds, that it is hardly noticed by those who live and work in the vicinity.

The noise is somewhat lessened by the wooden hood which conceals the rods from view, but it cannot be entirely abated.

Hair-picking.—This trade only gives rise to a public nuisance where the hair of mattresses, pillows, and furniture is cleaned by machinery. The matted and compressed hair is picked to pieces and the dust blown out of it, and the nuisance caused is of the same character as the last two, excepting that the noise of the machinery is not excessive.

These establishments are not often the subject of complaint, because they are not usually in the vicinity of dwelling-houses. I have never seen any special effort made to prevent the escape of dust from the premises. I would suggest, as a seemingly practicable method of disposing of it, to draw the air of the room rapidly away by means of a large fan or blower, and force it into the furnace of the engine which drives the machinery. To change the air of a large room in this way sufficiently often would require a large blower and a considerable expenditure of steam, and would also subject the workmen to draughts of cold air rushing in to supply the place of that which had been exhausted. These objections might be so potent, that, in case of a nuisance requiring suppression, the proprietors would prefer to move away rather than make the proposed alterations.

Street-sweeping.—This is also a prolific cause of dust in towns. The street dirt is of a very composite character, and contains animal and vegetable matter, as well as mineral. The effect of the inhalation of this dust is hard to estimate: it produces coughing and irritates the conjunctiva, and in some persons may excite nasal catarrh. In order to render the nuisance as slight as possible, the sweeping should only be done at night,

preferably in the early morning, and the streets should be sprinkled before the brooms are used. The subject is more fully considered elsewhere.

3. *Trades that are offensive on account of the noise caused by them.*

The three trades below-mentioned cannot well be carried on, it seems, without noise. Indeed, one of them has for its sole end the production of noise. It is undeniable that to nervous people and invalids these street-noises are often very distressing, and the health of delicate persons, it is conceivable, may be injured by them. On the other hand, the persons engaged in these occupations belong to the poorest classes, and often have hard work to make a living, and it becomes a question of great delicacy for public authorities whether they ought to be suppressed or not.

Street-vending.—The cries of the street-venders are heard in cities from morning till night. Their voices are peculiarly shrill, and have been so trained as to have a penetrating quality that allows no one to get beyond their reach, even in the rear rooms of houses. In New York these cries, reinforced by the ringing of bells and the blowing of tin horns, begin at 5 A.M. with the "yŭŭŭp" (contraction for "Here you are") of the milkman, and end at ten or eleven at night with the last fruit-sellers on the avenues.

Street-music.—This is mostly produced by hand-organs, but there are also performers on the flute, cornet, fife, hurdy-gurdy, harp, and violin. There are also itinerant brass bands of three or four pieces, and a few individuals try vocal music. With the exception of a few tolerable players on the harp and violin, the music furnished by these people does not deserve the name, and constitutes an unmitigated nuisance.

Junk-dealing.—The men who collect rags, bottles, and old tin or earthenware, go about with small hand-carts hung with cow-bells, which create an easily recognizable but intolerable discord. So much noise is caused by the jingling of the bells that they are not usually obliged to supplement it by their voices.

All of these nuisances are perhaps unavoidable, but they should be restrained within proper limits. In New York, a city ordinance forbids street-music before 9 A.M. and after 9 P.M. This ordinance should be extended so as to include the other nuisances mentioned, and I think the evening limit should be put at 8 P.M.

II.—Offensive Processes.

Those businesses in which the substances dealt with are offensive as a result of CHEMICAL *manipulation.*

In most of the processes here treated of, heat is used, either with or without the addition of acids or alkalies, and molecular changes are effected in the substances treated. In these decompositions and combinations new substances are formed in many cases besides the ones desired, and they are frequently very offensive, and may be very injurious

to the health of animals and vegetables in the vicinity. Accordingly, much attention has been paid in all manufacturing districts to the condensation or destruction of these deleterious or offensive products, and with considerable success. The means adopted will be noticed under the appropriate headings.

1. *Those processes which are offensive on account of the smell caused by them.*

a. *Manufacture of Animal Substances.*

This division includes the greater part of the processes included under the above heading. The offensive odor caused by them is due mainly to the decomposition of animal tissues, principally fats, under the influence of heat.

Fat-rendering.—Fat, as it comes from the slaughter-house, contains a large amount of albuminous matters, consisting partly of the membranes of the fat-vesicles, and partly of blood-vessels, scraps of muscular and fibrous tissues, with connective tissue in abundance. These albuminous matters readily decompose, and the fat itself absorbs oxygen from the atmosphere and becomes rancid, so that it has become the practice to separate the fat

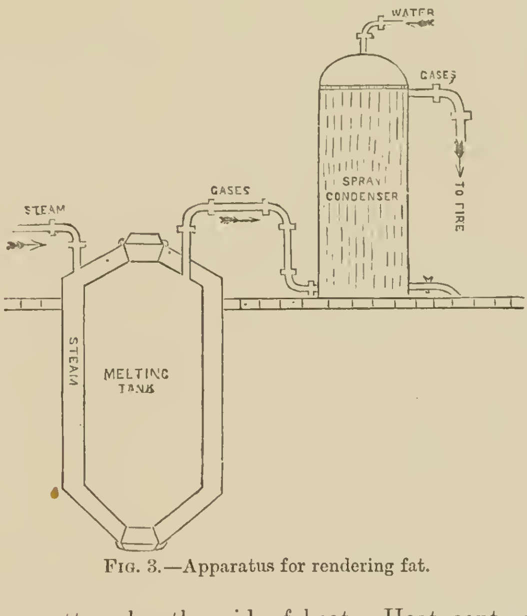

FIG. 3.—Apparatus for rendering fat.

from all other matters by the aid of heat. Heat contracts the membranes of the fat-vesicles, and causes them to shrivel up at the same time that the fat expands in volume. The vesicles therefore burst, and the fat escapes in a liquid form.

Fat is usually rendered in one of three ways: by direct heat from the

fire, by steam-heat applied outside of the kettle, or by steam introduced into the kettle or tank and mingled with the fat.

When fat is rendered over the fire, it is chopped up and put in a large pot or kettle set in brick, with a furnace underneath. After the extraction of the fat, it is drawn off by a faucet or dipped out with ladles, and the residue, known under the name of "scraps" or "greaves," is formed by a hydraulic press into a hard cake and sold for dog's food.

When fat is rendered by steam applied outside the vessel, it is put in upright cylindrical iron tanks, which are made double (Fig. 3). The inside tank contains the fat, and has an opening at the top, where the fat is thrown in, and another at the bottom, where the scraps are taken out, the melted fat being drawn off through a faucet. Outside this tank is another iron vessel, completely surrounding it, and called a "jacket." Between the two hot steam is introduced, a safety-valve and steam-gauge being provided as in boilers.

A variety of this method of rendering is the water-bath. Lockwood and Everett's tank, much used in New York, is of this kind (Fig. 4). The tank

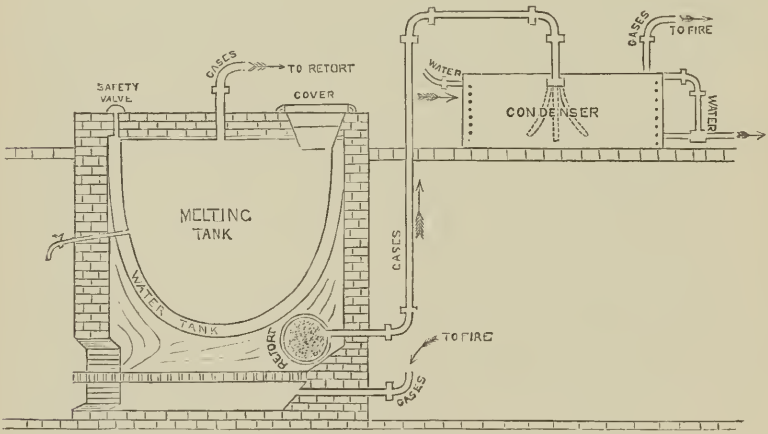

FIG. 4.—Lockwood and Everett's tank, with Bond's condenser.

containing the fat is set in a tank containing a certain amount of water, and underneath this outer tank is a furnace. The heat to which the fat is exposed is thus increased slowly up to about the same degree as in the method last mentioned. This is essentially rendering by means of a steam-jacket.

In other establishments the tank is single, and the steam is introduced directly into the fat (Fig 5). By this method the fat is mingled with considerable water, and the residue is so disintegrated that it is useless excepting for manure, and it is generally disposed of to the manufacturers of fertilizers.

Fat-rendering establishments are very liable to be public nuisances, on account of the offensive odors arising from them. These odors are

caused partly by the storage of decomposing fat on the premises, but mainly by the destructive distillation of portions of the fat, which produces certain ill-smelling substances, such as acrolein and allylic alcohol, with sometimes capric, caprylic, and caproic acids.

The melting of tallow is more likely to cause a nuisance than the melting of lard. The latter article, to be marketable, must be perfectly un-

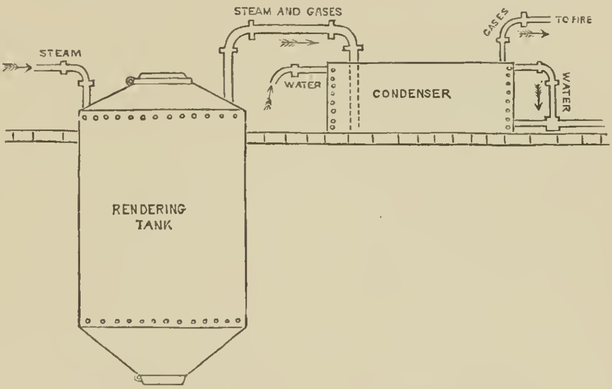

FIG. 5.—Steam tank with running-water condenser.

tainted, while tallow is not rendered useless by a slight rancidity. The rendering of lard therefore is sometimes carried on in open vessels, and where this is done there is comparatively little odor perceptible, until the fat is drawn off and the hot scraps are removed, when gases pass off having much the smell of an ordinary kitchen when articles of food are fried.

Notwithstanding the offensiveness of fat-melting, it is doubtful whether these vapors and gases are actually injurious to health, excepting in an indirect way. To most people the odors are disgusting, and if exposed to them, they must keep their doors and windows closed, and deprive themselves of fresh air. In delicate persons, it is said, anorexia, headaches, nausea, and even vomiting may be caused by them. I have yet to see such a case myself. A short exposure to the atmosphere of such an establishment renders one habituated to the smell, and the workmen are generally in vigorous health. But although probably not detrimental to health, these smells are destructive of comfort, and certainly constitute a serious public nuisance. I may be pardoned for quoting from Ballard, who has made extensive investigations on this very point. He says (p. 201): "I have not been able to discover that any other injury to health has been attributable to the fat-melting nuisance than that dependent upon its disagreeable impression on the senses. In hot weather especially the smell of melting fat is, from its associations, unpleasant and even nauseating to some delicate persons who, at that season, are unpleasantly impressed even by the smell proceeding from their own kitchens. In the Southampton case one person stated that his workwomen had to give up

their work in the summer-time, in consequence of their health being injured by the closeness of the room, arising out of the necessity of keeping the windows shut to exclude the intolerable smell. Others complained of being made sick, and one lady, not generally a delicate person, of frequently suffering from diarrhœa after about half an hour's exposure to the smell." These latter statements, coming from people who are trying to suppress a nuisance, are naturally liable to be exaggerated, and must be taken with allowance.

The only way to abate the nuisance caused by fat-melting is to confine the offensive gases, so as to prevent their escape into the external atmosphere, and to destroy them as fast as they accumulate. The gases themselves are combustible, but there is usually more or less water mingled with them in the form of steam, which must be condensed before the gases can be burned. Accordingly, fat-rendering is now done, for the most part, in perfectly tight kettles or tanks, and the gases and vapors are passed, as fast as they are evolved, through a condenser, where the watery vapor is retained, and thence into the furnace, where they are consumed.

There are many varieties of apparatus in use for this purpose, of which it will be sufficient to mention those which have been proved to be most effective.

The simplest form of condensing apparatus is that in which the gases are conducted from the kettle by a pipe to either the top or the bottom of an upright iron or copper cylinder, through which there is a constant flow of water in the form of jets or spray (Fig. 3). The water may be discharged on a perforated plate, near the top of the cylinder, whence it falls to the bottom in fine streams, or it may be a little more scattered by a rosette, or it may leap down from one to another of a series of shelves placed alternately on one side and the other of the condenser, from the top to the bottom, or the form of condenser called a scrubber may be used, in which the cylinder is loosely packed with a porous material, usually coke, kept wet by a constant trickling of water through it. (See Fig. 6.) In all these forms the condensation is much more perfectly accomplished if the gases are introduced at the bottom, and have to work their way upward against the current of water. Another pipe leads from the end of the condenser, opposite to that at which the gases enter, to the furnace. Thus the furnace-draught exercises a powerful suction on the contents of the condenser, and keeps up a constant circulation through it. The gases are consumed in the fire, and thus are not only prevented from creating a nuisance, but also serve in a slight degree as fuel.

Many houses in New York use Bond's Condenser, which is a little more complex. In this the gases from the boiling fat are first passed into a retort containing iron chips and turnings, built into the back of the furnace. (Fig. 4.) In this it is claimed the gases are deodorized by the withdrawal of some of the oxygen and sulphur, which combine with the iron. Thence they pass into a tank filled with running water, and from there finally into the furnace fire.

II. Vohl's apparatus, used in Europe, combines a purifier and scrubber. (Fig. 6.) The gases are first passed downward over a series of shelves, one under another, covered with powdered lime. From the bottom of

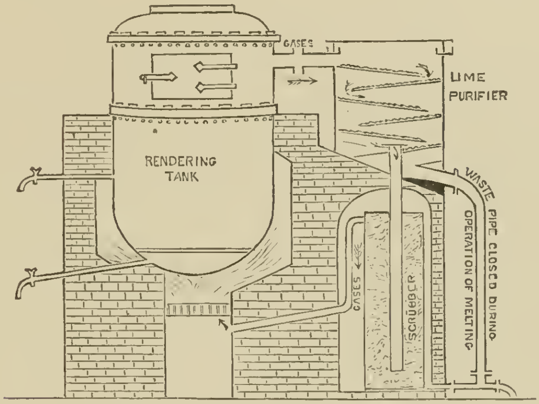

Fig. 6.—Vohl's fat-rendering apparatus.

this purifier a pipe runs downward to a point near the bottom of a scrubber filled with coke, moistened with sulphuric acid. From the top of this scrubber another pipe conveys the gases to the furnace fire. At the most dependent portions of the purifier and scrubber are waste-pipes, which convey the condensed fluids to the sewer.

As it is often desirable to watch the fat while it is subjected to heat, these steam and gas-tight tanks are provided with a mica plate at some point, through which its changes can be accurately noted.

The above means are sufficient to prevent the escape of any offensive odors, provided the apparatus is kept in proper repair and not allowed to leak. Attempts have been made, however, to abate the nuisance by changing the method of rendering, so as to prevent the evolution of offensive gases at all. This is done by rendering the fat at a temperature so low as not to decompose it.

D'Arcet has proposed to separate the fat from its membranes by means of sulphuric acid. One hundred parts of fat, chopped fine, are put in a kettle with fifty parts of water and one part of sulphuric acid (concentrated 1.85) and heated to a temperature of 105°–110° C. (220°–230° Fahr.). The sulphuric acid attacks the albuminous tissues, allowing the fat to melt out freely. There are some vapors of sebacic acid evolved (Tardieu), but they are not so plentiful or so strong as by other methods. The tallow produced is hard and white, and from 83 to 85 per cent. can be obtained by this process, while the ordinary methods give only 80 to 82 per cent. The scraps, being mingled with sulphuric acid, can only be used for manure.

Evrard at Douai mingles the fat as it comes from the animal with a dilute solution of caustic soda. The alkali dissolves the animal mem-

branes, freeing the fat, and also fixes the offensive fatty acids by saponifying them. This method produces a very white, inodorous tallow, and never requires a heat of more than 100° C. (212° Fahr.). After the rendering is complete, the alkaline liquid containing the fatty acids is decomposed by dilute sulphuric acid, and the offensive acids thus obtained sold to manufacturers of soap.

Cook has proposed to comminute the fat and render it at a very low temperature, viz.: 120° Fahr. The enveloping membranes are crushed and torn, and the temperature is barely high enough to make the fat assume the liquid form and separate from the other tissues. This is necessarily a slow process, and requires so much manipulation that it is not likely to come into general use.

Lard-refining.—The lard which comes from the first rendering of pork-scraps, contains impurities, which make it unfit for the general market until it has been refined. The process of refining consists in remelting it and mingling it with water by means of revolving paddles, and then allowing the water containing the impurities to settle. The clean, white lard is then packed in tins for sale.

As the temperature used is barely sufficient to melt the lard, and none of it is decomposed, the odor from these establishments is not offensive, excepting to the most delicately constituted persons, and does not give rise to a greater nuisance than ordinary cooking. Occasionally, however, the proprietors of such establishments will refine inferior qualities of "grease," which are offensive even in a congealed condition, and when heated even moderately give forth most disgusting odors. In such cases, condensers are necessary, as described above for fat-rendering.

Soap-making.—In the manufacture of soap, fats and oils are mingled with alkalies and boiled. The mixing is done in immense kettles, sometimes fifteen feet wide and thirty deep, and heat is applied either by the direct flame, or by a steam-jacket, or the steam may be infused into the mass. The fats are decomposed, and the fatty acids which are liberated unite with soda to make what is called hard soap, or with potash to make soft-soap. Excepting for the very finest soaps, the manufacturers use inferior qualities of fat, the "grease" of pork-scraps, butchers' trimmings, and the refuse fats of domestic kitchens. By the time it reaches the soap-factory, these fatty substances are often in a highly offensive condition, and it is the heating of such fat that gives rise to the nuisance connected with soap-making. If the fat is in the form of scraps and trimmings, it has to be rendered, and if it has been previously rendered and is brought to the factory in barrels ready for use, it has to be taken out by melting. This is generally done by placing the barrels side by side over a trough or gutter, with the bung-hole downwards, and inserting a jet of steam into the bung-hole. The fat, as it melts, runs along the gutter into the kettle or vat prepared to receive it. The heat to which the fat is subjected in any case, whether rendered or simply melted, is sufficient to cause an abundant evolution of offensive gases.

A certain amount of nuisance is also caused by the collection and

storage of offensive fatty substances even in a cold condition. This is to be avoided by having such matters collected in perfectly tight receptacles, and not opening them until their contents are required. The nuisance of the fat-rendering is to be abated by the use of condensers and the burning of the gases, but where the materials rendered are extremely offensive, unusual care is required to guard against leaks in the apparatus. The nuisance caused by melting "grease" out of the barrels is more difficult to control. In B. T. Babbit's immense factory in New York, this operation is performed on the upper floor of a six-story building, and the mingled steam and gases escape into the external atmosphere through the open windows. Although this factory is located in a populous neighborhood, the gases become so quickly diffused, that I not only have never perceived them myself, but have never received any communication regarding them from any citizen. If it should become necessary to abate the nuisance produced by this operation, it might be done by keeping the room tightly closed, with the exception of a ventilating-flue for the entrance of fresh air, and having the vapors and gases drawn from the room by a powerful blower and sent through a condenser and into the furnace fire.

Glycerine-refining.—By the decomposition of the fats in soap-making large quantities of glycerine are formed, which, however, is very impure, being contaminated with saline and empyreumatic substances, and having a very disagreeable odor. The residuary liquors are evaporated and treated with alcohol, which dissolves out the glycerine. The alcohol is then evaporated, and the glycerine remaining behind is diluted with water and then boiled with animal charcoal. This latter process has to be repeated several times, until the glycerine is free from smell.

If special means are not adopted to prevent the escape of offensive odors during these operations, the establishment is a very great nuisance. Attempts which have been made in New York, by means of tightly-covered kettles and condensers, to abate the nuisance, have not been very successful, and it seems best to remove such a business to a sufficient distance from dwellings to prevent the odors from being perceived.

Gut-cleaning.—The small intestines of slaughtered animals are used for sausage-casings and for making catgut. For these purposes only the peritoneal layer is required, and the separation of this layer from the others forms a business by itself. The guts are laid in a tank of water for six or eight days, until the connective tissue is very much weakened by putrefaction. They are then removed and laid upon a table, when workmen, by means of blunt knives or wooden instruments, press the mucous and muscular coats along from one end to the other. The peritoneal coat is then thoroughly washed and cleaned and handed over to the sausage- and catgut-makers.

This business is one of the most offensive possible, for the air of the room is filled not only with the gaseous products of putrefaction, but with fæcal odors from the imperfectly washed intestines. The business necessitates a copious use of water, and the floor and sides of the room are

always wet and sloppy, while the abundant moisture favors the further putrefaction of animal matters that may through carelessness be left on the premises.

Notwithstanding the extremely offensive character of this business, it is the general belief of writers on the subject that the odors from these places are not detrimental to health. Parent-Duchâtelet, quoted by Tardieu, says that the emanations from gut-cleaning establishments can be respired with as much impunity as the sweetest odors, and that neither the workmen who live in the offensive atmosphere nor persons who are temporarily exposed to it experience the slightest unwholesome influence. Moreover, the smells from such establishments rarely diffuse themselves to any great extent, and they can seldom be perceived beyond the doors of the shop.

Nevertheless, under certain conditions, the odors may affect the public, particularly in summer, when every door and window is wide open. The business should therefore be carried on in such a way as to reduce any possible nuisance to its minimum. To this end the water of the tank in which the intestines are macerated may be disinfected, as is sometimes done in France, by a weak solution of chloralum or chlorinated soda. This is said to abate the nuisance entirely, and not to injure the tissues in any degree. The time of maceration may be shortened by warming the water to 80° or 90° Fahr. The place should be kept as clean as possible, and to aid in this, the tables should be stone slabs and the floor of asphalt. All scraps should be immediately removed, and the floor and walls washed after the day's work is over. All liquids should be run off into the sewer by a drain in some part of the floor.

Bone-boiling.—Bones are boiled for the purpose of extracting the fat and the nitrogenous matters, which, by the action of hot water, form gelatine or size. They are boiled in large kettles, either by the direct application of fire, or by a steam-jacket, or more commonly by the direct introduction of steam into the mass of bones. The long bones are sawn in two lengthwise, so as to expose the marrow, and after prolonged boiling the size and fat separate, and can be drawn off to cool. The fat is then sent to the soap-makers, while the size is used by the manufacturers of felt and various prints. Those of the long bones that are suitable for the purpose are used in the manufacture of buttons and knife-handles, and the remainder are sent to the fertilizer factories.

If the bones are perfectly fresh, the odor given out while they are boiling is not unpleasant. It is merely the smell of boiling broth or soup. But if, as often happens, they are tainted, and the fats in them have become rancid, the odor is insupportable. If bones are allowed to accumulate in large quantity before boiling, they soon become offensive.

The storage of bones has already been spoken of. Wherever offensive bones are boiled, so that the establishment is likely to be a public nuisance, the kettles should be provided with tight covers and condensing apparatus, as recommended for fat-rendering.

Tripe- and offal-boiling.—Tripe, the first stomach of the ruminating

animals, has to be thoroughly cleaned before it is fit for the market. This is done by washing and scraping, and, if perfect cleanliness is observed, and all scrapings are removed daily, such places do not create a nuisance. Neither does the boiling of tripe for food.

Offal of various kinds is sometimes boiled for dogs and cats or swine. If it is fresh, no nuisance is created; but if it is tainted, the odors from it may be very offensive. In such cases, tight vessels with condensers must be used, and the bad smells which escape from the hot boiled meat, after it has been taken from the kettles or tanks, may be obviated by putting it immediately in cold running water (Ballard).

Blood-boiling.—The blood of slaughtered animals is boiled for the purpose of coagulating its albumen and bringing it into a fit condition to be used in the manufacture of fertilizers. For this purpose the blood is put in large tanks and steam discharged into it through movable pipes, which can be directed toward different parts of the mass as desired. After coagulation, the blood is put into the "driers," huge iron cylinders, which revolve inside a steam-jacket, and inside of which again are revolving arms, which continually stir the mass to keep it from burning. By these means the blood is converted into a fine brownish-red powder, with hardly any smell, and this is sent to the fertilizer manufacturer.

When blood is perfectly fresh, the odor evolved during these processes is not disagreeable, and would hardly be considered a nuisance. But blood is a very perishable article, and soon becomes putrescent, especially in hot weather. The smell is then exceedingly offensive. Special apparatus is therefore needed to overcome this source of nuisance. On board the "Algonquin," in New York, the difficulties have been successfully met. (Fig. 7.)

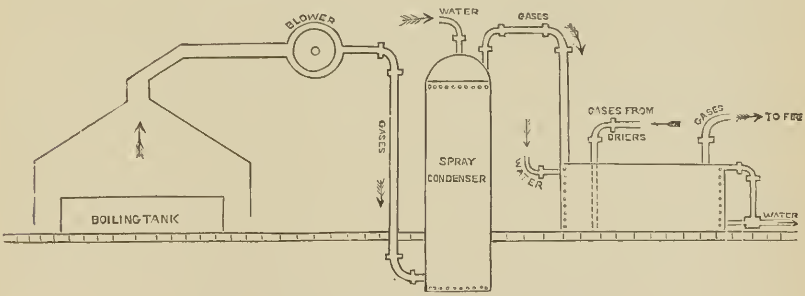

FIG. 7.—Blood-boiling apparatus ("Algonquin").

Over the boiling tanks or vats are large wooden hoods, which completely cover them, and the lower edges of which overlap the upper edges of the tanks, while under them and between them and the tanks is abundant space for a man to stand upright. From the tops of these hoods run flues which unite in a single one, at the further end of which is a powerful fan or blower, which draws all offensive gases from the tanks so perfectly that they cannot be perceived in the slightest degree just outside the hood. From the blower the gases and vapors are passed into the

base of a spray condenser, from the top of which they go to a horizontal condenser, filled with running water. This also receives the gases and steam from the "driers." From this last condenser all the uncondensed gases are drawn downward into the furnace fire, where they are so thoroughly consumed that at the top of the chimney not the slightest odor can be perceived, other than that of smoke or coal gas.

The blood should be kept in tight vessels until used, and the floors and walls must be kept clear of dried blood, or they will become offensive.

Pork-packing.—In establishments for pork-packing the pigs are purchased whole, and cut up on the premises. Some portions of the animal are then cured and smoked, while others are packed in brine, the trimmings being "tried out," or "rendered" for lard. There are only two points in the conduct of this business that are ever likely to cause a public nuisance. The first is the escape of smoke from the smoking-room. Bacon is cured by the smoke of hard-wood—oak or hickory being most frequently used. If the room is not perfectly tight, the escaping smoke will enter other premises, and to some people it is very disagreeable, because there goes with it a certain amount of odor from the heated bacon.

The second source of nuisance is the waste brine, which is often poured into the street gutter, and as it contains an appreciable amount of blood and other albuminous matters, it soon becomes putrescent and offensive.

To prevent these nuisances, it is only necessary to have the smoking-room perfectly tight, and so arranged that at no time can any smoke escape from it excepting through a flue, which discharges it above the tops of the neighboring buildings, and to have the floor of the room where the brine is changed graded toward a drain, which shall carry all refuse liquids into the sewer.

Tanning and leather-dressing.—The skins of slaughtered animals are cleaned to some extent immediately after killing. Bullocks' hides are washed to free them from blood, and then salted down in layers, or dried, as in South America and Texas, for export. Sheepskins are taken by the fell-monger, and soaked in vats containing milk of lime, which loosens the wool. After the wool is removed, the skins are put back in the lime-bath until ready for dressing. Tanning is properly the making of leather out of bullocks' hides, while the finer skins, as those of sheep, calves, and goats, go to the leather-dresser.

To prepare skins for the final operation of tanning, they are thoroughly cleaned, deprived of the hair, and soaked in different fluids, to render them soft and supple. After liming, all adherent flesh and hair are removed, the skins are trimmed at the corners and edges, and then placed in a vat containing dog's or pigeon's dung, to undergo the process called "puering." They are kept in this bath from ten minutes to two or three hours, until they become supple, when they are removed, and then undergo the regular processes of tanning.

The chief sources of offence in this business are the storage of offen-

sive matters on the premises, such as hides that have been imperfectly cured or cleaned, so that the blood and flesh still adhering to them is putrescent, the retention of fleshings that have been already removed, the ammoniacal odor that comes from the limed hides when they are taken from the vats and drained, and the intolerable smell given off by the "puering" vats.

The first source of nuisance may be obviated to a great extent by perfect cleanliness and the prompt removal of scraps and fleshings. If the latter are allowed to accumulate on the premises, they should be disinfected. The other nuisances cannot be suppressed. It would seem as if some less offensive material might be used than the so-called "puer," but those who are engaged in the business say that nothing else answers the purpose (Ballard). It would seem, then, that tanneries should be removed to a distance from dwelling-houses, or at least that the "puering" vats should be put on the farther side of the yard.

Glue-making.—The clippings of hides, the ears, hoofs, and useless skins are utilized in the manufacture of glue. The matters are first soaked in milk of lime, to clean them of blood and flesh, and remove the oil, and then boiled in water over a fire. The mass is boiled until the liquid produced will gelatinize on cooling, when it is drawn off into another kettle, where it is sometimes allowed to cool, and at other times is kept warm without stirring, in order to allow impurities to sink to the bottom. The clear liquid is then again drawn off and allowed to cool. The resulting jelly, cut into slices and strips, and dried, forms the glue of commerce.

The offensive part of this process is the boiling of the animal tissues, which are often in a very offensive condition. The odor given off by such works is sometimes intolerable, and yet it is the general belief of sanitary writers, that, like other offensive animal substances, the gases are not deleterious ones. The only opinion to the contrary that I have met with is that of Dr. Goldie, Medical Officer of Health for Leeds, England, quoted by Ballard (op. cit., p. 183). He says that during the six years ending December, 1875, in an estimated population of 1,935 persons, not exceptionally poor or overcrowded, exposed to effluvia from the Hunslet Glue-Works, "the mean annual mortality from all causes amounted to 35.6 per 1,000, while that from the five zymotic diseases, small-pox, scarlatina, measles, fever, and diarrhœa, amounted to 9.12 per 1,000. Taking the whole Hunslet ward in which this little colony is situated, the annual death-rate from all causes during the same six years varied from 27.0 to 29.9, the mean being 27.9; and the death-rate from the five zymotic diseases mentioned varied from 4.6 to 6.0, the mean being 5.4. Dr. Goldie tells me, from his knowledge of the district, that he is not aware of any conditions of locality or character of population that could possibly account for the great mortality about the glue-works, other than the presence of the offensive works themselves." As this testimony is so at variance with the opinions of others, it is difficult not to believe that there are some as yet undiscovered reasons for this difference of nearly 100 per cent. in the mortality from zymotic diseases, especially as small-pox,

scarlatina, and measles are not supposed to be due to any other than a specific poison. The very fact that a certain number of people dwell near offensive glue-works would seem to imply that they were very poor and not able to live in better quarters, and poverty always means bad food, bad air, and bad habits of life.

The offensive vapors from boiling glue are to be condensed and burned upon the same principles as those from melting fat, and the accumulation of offensive material on the premises should be avoided as far as possible.

Shell-burning.—The shells of shell-fish are burned in large quantities for the sake of the lime. As they contain some animal matter, and there are often portions of the shell-fish still adhering to them, the process gives rise to disagreeable odors.

The only remedies would seem to be the removal of such establishments from the vicinity of dwelling-houses, or the erection of a tall chimney connected with the kiln, so that the unpleasant gases might be diffused in the upper atmosphere.

Recapitulation.

The chief sources of nuisance, therefore, in the manufacture of animal substances are:

1. Storage of offensive material.
2. Uncleanliness.
3. Evolution of offensive gases as a result of the application of heat to animal substances.

And the remedies suggested are:

1. Storage in tight vessels.
2. Frequent washing, good drainage, prompt removal of refuse.
3. Passage of the offensive vapors and gases through condensers, and thence into the furnace flames.

b. *Manufacture of Vegetable Substances.*

Brewing.—Beer is almost invariably made from barley. The grains, which are carefully selected, are put in large vats or tubs, made preferably of stone or cast-iron, and covered with three or four times their volume of water, at about 60° Fahr. After they have been soaked sufficiently, the water is drawn off, and the grain is spread over the floor of the germinating-room in heaps. During germination the gluten of the grain is changed into diastase, which is afterwards the means of converting the starch into sugar and dextrin. When this process has reached a certain point, the grain is removed to the drying-room, where it remains for a short time, and is then ready for roasting. This latter process is carried out in kilns, and has for its object the production of certain empyreumatic substances, which affect the color and taste of the beer. The roasted malt is then ground in mills, which do not pulverize, but only crush it.

The malt thus formed is now mixed with warm water in the mash-tubs, where it is stirred by revolving arms, so as to bring the water into intimate

contact with all of the grain. The water enables the diastase to act upon the starch, and also dissolves the sugar as fast as it is formed. The liquid (called wort) is run off at intervals, and a fresh quantity supplied. As it comes from the vats, it contains about five per cent. of sugar and six per cent. of dextrin, with nitrogenous and other constituents. The wort is then boiled, hops are added, the solution cooled and fermented.

The offensive odors which sometimes come from breweries are caused by the retention of matters on the premises which undergo the acetous fermentation. If the drainage of the soaking vats is not good, the water in which the grain is first steeped may not be carried off, and may become offensive. If the crushed malt, after the wort has been drawn from it, is stored on the premises, it very quickly becomes sour and offensive. If the floors and walls of the different rooms are not kept perfectly clean, the substances adhering to them may decompose and taint the malt as well as the atmosphere.

To prevent any of these nuisances, the floors and walls of the rooms where moist matters are handled should be water-tight and entirely free from crevices and holes. They may with advantage be made of asphalt or concrete. They should be well drained, and all waste liquids should be immediately run off into the sewer. The place should be kept scrupulously clean, and the mash, after its virtues have been extracted, should not be kept on the premises, unless it is stored in tight vessels. It is better to remove it while it is fresh and sweet.

Gas-making.—Illuminating gas is produced by the destructive distillation of bituminous coal. The coal is put into large retorts, which are maintained as nearly as possible at a cherry-red heat. The gases which pass off form a very complex body, containing many impurities besides the compounds which give it its illuminating power. These impurities are chiefly sulphuretted hydrogen, ammonic hydrosulphide, ammonic carbonate, carbonic anhydride, carbonic disulphide, and aqueous vapor. There are also various condensable hydrocarbons, which would soon clog the service-pipes, and which therefore have to be separated during the process of manufacture. It is necessary to have the sulphur compounds and the ammonia also removed, because during the combustion of the gas the former bodies would form sulphurous anhydride, which, absorbing water and oxygen from the air, would form sulphuric acid, and thus be deleterious to health and injurious to almost everything exposed to its influence, while the ammonia, by combustion, is liable to form nitrous compounds, which may be fully as noxious as the former.

The chief apparatus of a gas manufactory, therefore, is that for cleansing the gas by separating these impurities. As the gas leaves the retort it is conveyed by pipes to the hydraulic main, a cast-iron trough half filled with water, into which the pipe dips downward. The gas bubbles through, but a part of the tarry matters and of the ammoniacal liquor is condensed, and runs off by special means provided for the purpose into the tar-well. From the hydraulic main the gas goes to the condenser, a series of iron tubes containing pipes with running cold water. Here the gas is cooled and de-

posits other condensable tars and water. From the condenser it is drawn by an "exhauster," which drives it through the scrubber. This consists of one or more cast-iron cylinders divided into two parts by a partition running from the top nearly to the bottom. These cylinders are filled with coke, which is generally moistened with ammoniacal liquor. The gas enters at the top of one division of the scrubber, passes down through the coke to the bottom, then up through the other division, and so out. Here a considerable part of the ammoniacal compounds are left, and nearly all the remaining tar. The ammoniacal liquor from these scrubbers, containing ammonia in combination with carbonic acid and sulphuretted hydrogen, together with sulphuric, sulphurous, cyanic, sulphocyanic and hyposulphurous acids, with a little free ammonia, is used in the manufacture of ammoniacal salts.

The remaining impurities are carbonic dioxide (carbonic acid) and sulphuretted hydrogen. To remove these, the gas is passed through purifiers. These consist of a series of shelves in a closed chamber, covered with quicklime or hydrated ferric oxide, so arranged that the gas passes downward over one series of shelves and then upward over the other. The lime is thus partially converted into calcium sulphide, and the iron into the sesquisulphide, and the contents of the purifiers must be occasionally exposed to the air for reoxidation. When the lime is thus oxidized, it gives off ammonium sulphide and sulphuretted hydrogen, while from the iron free sulphur is precipitated. The lime can in this way be used again and again, while the iron, after sufficient free sulphur has accumulated to impair its efficiency (about 40 per cent.), is utilized in the manufacture of sulphuric acid or other chemicals. After leaving the purifiers, the gas is ready for consumption, and is stored in the gasometers.

The offensiveness of gas-works is due partly to the escape of gas through leaky joints and from the water-seals of the gasometers, and partly to the exposure of the lime from the purifiers, when the ammonium sulphide and sulphuretted hydrogen given off render the vicinity of the works very offensive.

Even with the best workmanship and the closest attention, it seems impossible to prevent occasional leaks in the apparatus used. There are so many feet of pipe and so many joints, both in the pipe and in the different chambers, and the pressure of the gas is so great, that the odor of escaping gas is often the first indication of an imperfect joint. Of course, the remedy for leaky joints is proper luting. The parts are commonly fastened together by screws and nuts, by cement, or by lead.

The chief reason for clinging to the lime method of purifying gas is that it not only removes the sulphuretted hydrogen but the carbonic anhydride, which impairs the illuminating quality of the gas. Attempts have been made to cleanse the lime of the impurities absorbed by it by blowing pure air over it in closed chambers, but they have not been very successful, and it seems that the lime-purifiers should be given up. The iron purifiers cause no nuisance, and should be adopted, in one or another of their numerous modifications, in all gas-works. With the best of care,

however, the nuisance of gas-works cannot be entirely abated, accordingly such works should not be allowed in the immediate vicinity of dwellings. In England, according to the Gas-works Clauses Acts of 1847 and 1871, factories are not allowed to make gas or work over residues without written permission of owners, lessees, or temporary tenants of all inhabited houses within 300 yards of the works.

Distilling.—Establishments for the distillation and rectification of spirits are all conducted upon the same principle, though with variously modified apparatus. The liquids containing alcohol are subjected to the action of heat, and the alcoholic vapor is condensed by being carried in a spiral-pipe, called a "worm," through a vat of cold water. The nuisance caused by these establishments is due partly to the refuse water which has been used to wash the apparatus, and partly to the residues of the distillation.

The refuse liquids of distilleries are run into sewers or discharged by drains into the nearest water-course. The pollution of water caused thereby will be treated of elsewhere. When the more solid residues of the process are burned or carbonized on the premises, very offensive odors escape from the furnace. The gases evolved can be partially destroyed by passing them through a second furnace, behind the carbonizing space, but their destruction is not completed in this way, and a tall chimney is necessary, so that they may be sufficiently diluted before reaching the ground to be unnoticed.

Sugar-refining.—Sugar, as it comes from the first maker, is not yet fit for the market. It contains various impurities, as sand, earth, bits of crushed cane, coloring matters, albumen, various salts, as potassium chloride and nitrate, sodium chloride, calcium carbonate, phosphate and malate, and magnesium phosphate, besides vegetable acids (malic, pectic, acetic and lactic), in sugars which have come from the tropics and undergone slight fermentation (Payen). To remove these substances, the sugar is subjected to various methods of treatment, and among others that of filtration through animal charcoal. The charcoal after a time becomes so loaded with impurities that it no longer purifies the fluids that pass through it. It does not thereby become useless, but, if heated to a red heat, recovers its valuable properties. This process, called "revivification," is attended with the evolution of very offensive gases (according to Dr. R. D. Thompson, carbonic anhydride, carbonic dioxide, various hydrocarbons, ammonium sulphide, ammonium acetate and carbonate), and constitutes the principal nuisance connected with sugar-refining.

In this process, as in the one last mentioned, the gases may be partially consumed by a second fire, but a tall chimney is necessary to abate the nuisance to any sufficient extent.

Vinegar-making.—The manufacture of vinegar and of pickles fills the air with the odor of acetic acid, which to many people is exceedingly unpleasant. It is better that such establishments should be removed from the immediate vicinity of dwellings, but if near dwellings, something may be effected towards abating the nuisance by thorough cleanliness. The

floors should be of impermeable material. In one case the nuisance caused by a pickle factory in immediate proximity to a dwelling was appreciably diminished by the construction of a shaft for ventilation, extending from the ceiling of the room in which the principal work was done to a point a foot or two above the roof of the adjoining house.

Varnish-making.—Varnishes are made by dissolving certain resins, as copal, mastic, and sandarach in turpentine, wood-naphtha, alcohol, or linseed oil, with the aid of gentle heat. Camphor is used in the manufacture of certain kinds of varnish, and of late also a number of other carbon compounds.

The heating of these resins, oils and spirits gives rise to peculiar odors, of a somewhat sickening character. As will be noticed, all of the substances used are very inflammable, and are brought in close proximity to fire. The business, therefore, is not only an offensive one, but exceedingly dangerous.

Such establishments should, therefore, be removed several hundred feet from the neighborhood of dwellings.

c. *Manufacture of Mixed Substances.*

Cooking.—Many of the substances used for human food give off very disagreeable odors while cooking. Indeed, to many the smell of a kitchen, during the preparation of any article of food whatever, is intensely unpleasant, while the bad smell of certain vegetables, as cabbage, turnips, and onions, and of some salted meats, is recognized by all. As the kitchen is generally situated in the cellar or basement of the building, the odors ascend toward the upper rooms, and often fill the entire premises. As long as the smell is confined to a single house, it does not come under our definition of a public nuisance; but the kitchens of restaurants or hotels, where immense quantities of food are prepared daily, are often so situated that the gases and vapors from them escape through the doors and windows and constitute a serious nuisance to the occupants of neighboring premises. This nuisance is liable to be worse in summer, not only because windows are then always open, but because such smells are to most people especially disagreeable in hot weather, for they almost invariably consist largely of fatty vapors and are physiologically repugnant.

The radical cure for this nuisance would be undoubtedly the removal of the kitchen to the top of the house, so that the heated air would pass out of the windows into the external atmosphere above the adjoining houses. In buildings supplied with elevators, this is quite practicable, and I have seen a public restaurant, the kitchen of which was located on the top floor. The odors may be somewhat confined by having a hood or cowl covering the range, and connected by a flue with the chimney. Where much frying or broiling is done, and a great amount of greasy smoke generated, this becomes almost a necessity. The ceiling and walls of the kitchen should be perfectly tight, as if there are crevices in them, the smoke and oily vapors will penetrate the partition walls, and so pass over the building, filling it for a considerable time with a stale, disagree-

able smell. In one case where the kitchen of a restaurant was in the basement of a building filled with offices, and its windows looked out upon a court lined with offices, all nuisance was abated by putting sheet-iron hoods over the upper part of the windows, connecting them with a flue extending above the roof of the building. When the windows are open, there is an inward current of cool air at the bottom, and a continuous current of hot air, laden with smells, upward through this flue. The action of such a flue may be assisted by a rotary ventilator at its upper end.

2. *Those processes which are offensive on account of the fumes caused by them.*

The peculiarity of the businesses grouped under this heading is, the production of acid gases which escape into the external atmosphere, unless special means are taken to confine them. The materials dealt with are not in themselves offensive, if we except the manufacture of superphosphates and ammonia with its salts, and the fumes evolved are by-products of the manufacture. The two businesses above mentioned as exceptions have been placed under this division of the subject rather than under the last one, because, although the odors given off by them are offensive, the emanations are mainly acid fumes, and the results of the process are chemical products. As the nuisance caused by these works is nearly the same in all, and the remedies are merely varied applications of the same principle, it will be more convenient to describe briefly the different processes, and then consider the extent of the nuisance and its abatement under one heading.

Manufacture of chemicals.—This heading would naturally include a vast number of processes, but only a few of them are conducted on a sufficiently large scale to give rise to a public nuisance. In the French classification, the manufacture of the different acids is included, but it is now a considerable time since the processes were so improved as to condense and save all of the fumes, instead of discharging them externally. The processes most productive of nuisance at the present day are the manufacture of ammonia and ammonium sulphate, of soda, and of the superphosphates used as artificial manures or fertilizers.

Ammonia and ammonium sulphate.—These substances are manufactured in immense quantities from the refuse ammoniacal liquor of gas-works. This liquor is very complex in its composition, containing ammonium hyposulphite, ammonium sulphide, ammonium carbonate and bicarbonate, ammonium snlphate and chloride, with a small amount of ammonium sulphocyanide and benzoate, and from one to five per cent. of free ammonia. This liquor is distilled and the ammonia condensed in a "worm" as it passes over. When ammonium sulphate is to be prepared, the ammonia is passed immediately into a lead-lined tank containing sulphuric acid, and the crystals raked out and drained of liquid as they form.

The nuisance caused by these works is due to the sulphuretted hydro-

gen, which escapes in considerable quantity from the refuse liquor. When the latter is run into the sewer, the offensive odors may be spread along the line of the sewer for a considerable distance.

Soda.—This substance is obtained by heating sodium sulphate in solution with lime, the lime withdrawing the sulphuric acid from the salt and leaving caustic soda. The sodium sulphate is prepared in the same works by the action of sulphuric acid on common salt. The decomposition is effected in a furnace, and immense quantities of hydrochloric acid are produced in gaseous form. It is desirable to save this acid on account of its commercial value; but although several successive water-condensers have been used, a large amount of gas always escaped from the chimney until within a few years past. These works also send forth fumes of sulphuric acid to some extent, and nitrous gases from the sodium nitrate used to purify the soda from the sulphites, hyposulphites and sulphides of sodium contained in the solution. As commercial sulphuric acid always contains a little arsenic (if made from pyrites, from 2 to 3 lbs. of arsenious acid to the ton), there is a little of the vapor of this substance also in the emanations.

Superphosphate of lime.—The preparation of artificial manures constitutes a very extensive and important industry. They are made of almost any material containing much phosphorus, nitrogen, and earthy salts. Ballard gives the following list of substances used: coprolites, apatite, phosphorites, South Carolina, French, and other mineral phosphates, Mejillones, Sombrero, and other phosphatic guanos, crushed bones, bone-char and bone-dust from sugar refineries and manufactories of animal charcoal, calcined bones, sugar scum, ammoniacal guano, blood, flesh, offal, leather, scraps of skin and wool, shoddy, scutch (refuse of glue-works), night-soil, salt, nitrate of soda, sulphate of ammonia, gypsum, soot and flue-dust, etc. It will be seen that this list includes almost everything that is useless for other purposes. Indeed, these manufactories but facilitate that application of waste animal matters to the soil, for the use of vegetable life, which nature accomplishes in a tedious manner.

The animal matters are subjected to the action of hot steam in tight tanks, made like the steam-tanks described under fat-rendering. When sufficiently disintegrated, they are removed to huge driers, like those heretofore described under blood-boiling. When removed from the driers, they constitute a dry, crumbling mass, almost odorless, and of almost unrecognizable nature. The manures are made of many substances mingled together, the mixture generally including considerable animal matter, with South Carolina or other phosphatic rock, and sometimes plaster-of-Paris. These substances are all ground to powder, and then put into a large tub or vat, called the "mixer." In this they are continually stirred by revolving rods and arms, while sulphuric acid is slowly added.

The fumes given off during the chemical action in the mixer consist mainly of sulphuric acid and fluorine compounds, with a small amount of arsenic.

Glass-works.—In the manufacture of glass, substances containing silica and others containing potash or soda are melted together, when the silica combines with the alkali and forms a silicate of potash or soda. The silicious materials generally used are fine sand, or quartz or flint stamped or ground to a powder. The alkali is supplied by sodium sulphate, or by refined or crude potash. These substances are heated to a temperature of about 12,000° Fahr., in large crucibles placed in the furnace. In the impure materials used in the making of common glass there is often sodium chloride, and in Russia this forms a regular ingredient. For the different varieties of glass are also added lime, various metallic oxides, and borax.

From the reaction of these materials on each other are evolved fumes of sulphuric and hydrochloric acids, with perhaps sodium sulphate and chloride.

Potteries.—In the glazing of earthenware and porcelain, common salt is often used, and, as a result of the reactions which take place, the chimneys of these establishments pour forth a considerable quantity of hydrochloric acid.

Bleaching-works.—In establishments for the bleaching of vegetable substances and fabrics, where immense quantities of sulphurous acid and chlorine are used, enough may escape from the premises to constitute a serious nuisance.

Brick-making.—In the manufacture of bricks, common plastic clay is mixed with a certain amount of sand to prevent cracking and too much contraction when dried. They are then moulded and baked in kilns.

The baking of bricks produces irritating fumes, the exact nature of which has not been determined. The fumes are very fatal when breathed in a concentrated form, and are supposed to be mainly composed of hydrochloric acid. The presence of this acid is accounted for by the fact that the brick clay is often mixed with cinders, and in London with the siftings of dust-heaps, called "breeze," which are conjectured to contain an appreciable amount of sodium chloride.

Smelting.—The chief nuisance due to smelting is caused by the reduction of copper-ore. This ore consists usually of copper and iron pyrites mingled, containing these metals in the form of sulphides, with a little arsenic and antimony, and often silver. The ores are reduced by heat in reverberatory or shaft furnaces, and although a portion of the sulphur is obtained in a liquid, uncombined state, and run off into moulds, a good deal of it is oxidized and passes off into the external atmosphere as sulphurous oxide.

The fumes from copper-works, therefore, consist mainly of sulphurous oxide, with perhaps a little arsenic, and possibly some copper.

Refining.—After reduction of the ores in which they are found, gold, silver, and copper are obtained in the form of alloys, the proportion of each metal being subject to great variations. The decomposition of the alloy, so as to obtain each metal in a pure state, is called refining. The method of refining most likely to cause a nuisance is the so-called "wet method," by means of acids.

The alloy is first melted and then granulated by pouring it in a thin stream, from some height, into cold water. In this way it is obtained in small grains, which expose a larger surface to the action of the acids. The granulated alloy is then boiled in sulphuric acid until the silver and copper are completely dissolved, the gold being precipitated in the form of a fine, brown powder, which is removed, washed, pressed into cakes, and then melted. The remaining solution contains silver and cupric sulphates, and copper turnings are added in sufficient quantity to withdraw all the sulphuric acid from the silver, and thus precipitate it. The silver precipitate is then removed, washed, pressed, and melted, and the remaining solution is evaporated, when the cupric sulphate crystallizes. If there is no gold in the alloy, the latter portion of the process is alone necessary.

An alloy of gold and silver, containing sixty-six per cent. or more of silver, is often treated with nitric acid. The alloy is boiled in this acid until the silver is all dissolved in the form of nitrate, and the gold is precipitated as in the previous operation. The gold is then removed, washed, pressed, and melted, and the silver solution treated with sodium chloride, which precipitates the silver in the form of a chloride, from which state metallic silver can easily be obtained.

The first of these operations gives off copious fumes of sulphurous oxide, which, if allowed to escape into the external air, become oxidized and form sulphuric acid. In the latter process, fumes of nitric oxide are produced, which absorb oxygen from the air and form irritating reddish brown vapors, consisting of nitrogen peroxide, with perhaps some nitrous anhydride.

Assaying.—This process has for its object the determination of the exact amount of gold or silver in any given mass; *i. e.*, it is properly a quantitative analysis of metals. It depends for its success on the greater affinity of the baser metals for oxygen and chlorine over gold and silver. A small amount of the material containing gold or silver is melted in a crucible with lead and sometimes a little soda. The gold or silver is separated from impurities, and forms a button at the bottom of the crucible. The amounts of bases added, and the weight of the whole mass being precisely known, a close estimate can be made of the proportion of the noble metal.

As the amounts used in assaying are small, no nuisance of any account can be created by metallic or other fumes from the crucibles. But an exceedingly hot fire has to be kept up, and enormous quantities of carbonic oxide, carbonic acid, and sulphurous oxide, the ordinary products of the combustion of coal, are thrown out of the chimney.

Jewelry manufacture.—Both in the manufacture and cleaning of gold and silver ornaments, jewelers use nitric acid, and fumes escape from their windows and chimneys altogether similar to those described under refining.

These various fumes are very irritating to the respiratory mucous membrane. When the chimney from which they are discharged is in the open country, the gases are so diluted with air as to be hardly perceptible

to the occupants of dwellings in the vicinity. In the city, however, where people are crowded and brought by their daily business into close proximity with refining establishments, etc., the fumes may prove a serious annoyance. The tenants of offices near the United States Assay Office, in Wall Street, where refining is carried on extensively, used to be very much troubled with acid fumes, which made them cough incessantly, although no unpleasant odor was perceptible. I have myself felt a disagreeable tickling about the glottis, when in the neighborhood of the Assay Office, and an irresistible impulse to hawk and clear my throat, when I could perceive no odor in the air. Nitrous fumes, however, are especially irritating. The fumes of hydrochloric acid, on the other hand, are perceptible to the sense of smell in very small quantity, too small to be irritating. Angus Smith evaporated this acid in a closed space, and taking observations until the sense of smell could detect it, obtained results which he has tabulated thus:

Experiment.	Hydrochloric acid evaporated.	Volume of acid in chamber.	Amount of acid in one volume of inspired air.	
1	.1036 grammes. 1.6 grains.	.00128		No smell.
2	.1625 grammes. 2.509 grains.	.00202	.0000086 grammes. .0001328 grains.	Slight smell.
3	.2157 grammes. 3.33 grains.	.00269	.0000114 grammes. .000176 grains.	Distinct smell.
4	.25 grammes. 3.86 grains.	.0031	.0000133 grammes. .000205 grains.	Strong smell.

And he considers that three parts in 100,000 are distinct for all persons. So far as figures can show, the health of a population is not injuriously affected by such a contamination of the atmosphere. The Belgian Commission of Inquiry on "Fabriques de Produits Chimiques," in 1856, reported to this effect. The death-rate near such factories in four districts was found to have actually diminished since the works were established, the smallest difference being that between 1.53 per cent. before, and 1.508 after, and the greatest, 2.37 before, and 1.90 after. And I may add that, although, according to Angus Smith, the air of Manchester contains 1 part in 80,000 of sulphuric acid, and no plant can live in it, the death-rate of that city is not high, ranging between 27 and 29 per thousand.

But although the effects upon human health and life are so insignificant, it is not so with vegetation, which seems to be peculiarly susceptible to impurities of the atmosphere. The fields and gardens in the vicinity of alkali and copper-works, and therefore exposed to fumes of hydrochloric and sulphuric acids, become utterly unproductive. The scanty

crops struggle through a suffering existence, the leaves are blanched, or sometimes browned or blackened; the growth of fruit and grain is arrested, and the acid deposited on the grass and herbage produces disease in the cattle which eat them. The action of the acids on the health of plants is sometimes very rapid. Turner and Christison found that a reseda plant began to wither in two hours, with $\frac{1}{1000}$ part of sulphurous acid in the air, and the effect upon it was very striking with only $\frac{1}{9000}$ part of the acid. A remarkable result has been observed by Smith in wheat exposed to acid gases. The crop may be to all appearance full and ripe, when scarcely a trace of grain is to be found. This dies at an early stage, and withers up, whilst the rest of the plant takes its apparently usual course. Plants of a low order are more hardy, and mosses will grow in the acid rain of towns, when trees, shrubs, and grasses disappear.

The evil effects of such fumes sometimes extend to a great distance from the works. Sulphurous fumes do not travel far, but soon sink to the ground, while hydrochloric acid will go several miles, and chlorine will go four miles and be very distinct to the sense of smell, over smooth and unobstructed places. According to Stecker and Haubner, the browning and whitening of leaves of trees in Halsbrück district could be traced 3,500 or 4,000 feet, while the condition of fruit and cattle is affected at a distance of three miles from the Freiberg works. On the other hand, the Belgian Commission mentioned 2,000 metres as the greatest distance from chemical works at which damage was done to vegetation. The extent of the effects depends considerably on the height of the chimney. When this is very high, some of the gaseous products may be precipitated before reaching the top, but whatever vapors escape will not reach the ground until they have travelled a considerable distance. In 1861, there was a remarkable sickening and death of trees in the Grüllenberger Wald, chiefly firs, and it was believed to be due to the raising of a chimney to a great height about four miles away. The direction and force of the wind and the barometic pressure, together with the dryness or moisture of the air, will also have an influence on the locality and extent of country affected.

The great damage done by these fumes to crops and cattle has led to many suits against chemical factories in Belgium, Germany, France, and England. In the latter country, laws are in force to prevent, as far as possible, the escape of fumes from the works. The so-called Alkali Acts of 1863 and 1874 resulted from the agitation of the subject, and under the provisions of those acts, Mr. Angus Smith was appointed inspector to see that the requirements of the law were complied with. From his valuable reports to the Government many of the facts here used are taken. An idea of the magnitude of the nuisance to be controlled may be formed from Smith's estimate, that before the passage of the Act of 1863, the amount of hydrochloric acid, 25 per cent. strong, poured forth from alkali-works in England every year, was 208,000 tons (Report of 1864, p. 7). To remedy this condition of things, the Alkali-Works Regulation Act of 1863 was passed, providing that hydrochloric acid vapors must be condensed to the amount of 95 per cent. of those evolved.

This not proving sufficient to meet the case, the Alkali Nuisances Prevention Act of 1874 was passed, providing that the amount of hydrochloric acid in a cubic foot of air escaping from the chimney must not exceed one-fifth of a grain. This act also extends the operation of the former one to other chemical works. It classes as noxious gases sulphuric acid, sulphurous acid, with the exception of that coming from burning coal, nitric acid, or other offensive nitrogenous compounds with oxygen, sulphuretted hydrogen and chlorine. Copper-works in which salt is used, and chlorine and hydrochloric acid evolved, are looked upon as alkali-works. A committee appointed to investigate the subject, in a recent report, recommend that not more than one grain of sulphur in the form of acid be allowed to escape in one cubic foot of air, or more than one-half a grain of nitrogen, and that the present Alkali Acts be made to include chemical manure-works, coke-ovens, ammonia-works, tar-distilleries, gas-liquor-works, works for the manufacture of cobalt, arsenic, cement, dry or wet copper, glass, lead, nickel, salt, spelter, tin plate, potteries (salt glazing), and the manufacture of dyes from coal-tar derivatives.

As animal matters are utilized in superphosphate-works, certain disagreeable odors are generated in addition to the acid fumes. The smell proceeding from scutch manure-works is stated by Ballard to be peculiarly sickening. He says: "Dr. Gordon, the principal medical officer of the Woolwich garrison, described to me the odor proceeding from the scutch manure-works on Erith marshes as resembling, more than anything else, that which he had perceived in India when passing to the leeward of places in which the Hindoos burn their dead. To myself, the odor resembles that of very decayed and putrid cheese. The odor from superphosphate-works has, to my senses, something of the same character, especially marked when animal matters are used in addition to bones and phosphates." (Op. cit., p. 259.) I must confess, however, that in my visits to superphosphate-works in New York, I have not found the pervading odor so intensely disagreeable. There was some smell from the offal and blood which had just been brought to the works, but although the vapors from the mixer were not confined or condensed, there was little odor besides that of the acid. In the works at Newtown Creek, very offensive odors were produced by the use of "sludge" acid, *i. e.*, sulphuric acid which had already been used in the refining of petroleum, and contained various impurities.

The odor from superphosphate-works is of a very penetrating quality, and diffuses itself over a great extent of country. "The odor from the works of Morris & Griffin, at Wolverhampton, is said to be perceived offensively at Newbridge, a distance of one and a half miles; while that from the Erith Marshes 'scutch' manure-works was, on the occasion of my inquiry on the Thames, said to be an intolerable nuisance at the Woolwich Barracks, a distance of four and a quarter miles. Loud and grievous complaints are made in the town of Plymouth, of the offensive odors from the manure-works at Cattledown, a distance of about one mile, when the wind blows from that direction across the bay." (Bal-

lard: Op. cit., p. 259.) The odors from the works at Newtown Creek have frequently been wafted over the intervening half mile of water to the city of New York, and have been perceived distinctly at Sixth Avenue, distant about a mile from the river.

Remedies.

The methods adopted for the abatement of this class of nuisances depend for their success on the fact that acid fumes can be condensed and dissolved in water. Instead of being allowed to pass directly into the external air, therefore, they are confined in close tubes, and made to pass through "condensers" and "scrubbers." In condensers the water is made to pass in a spray or shower from top to bottom, and the fumes may enter at either extremity of the condenser, and pass out at the other. The most common forms of the condenser are those in which the water is spread from a rosette, or falls through a perforated plate, and those which are provided with shelves on each side, alternating in their position, so that the water leaps down from one to the other in a sheet. A scrubber is a cylinder or tower filled with coke, over which a constant stream of water trickles and keeps it wet. In some cases perforated bricks are used in the place of coke. The condensing effect of either apparatus is much greater if the gases are made to enter at the bottom and pass upward against the current of water. Very often more than one condenser or scrubber is required, and in some large establishments three or four are used, the vapors entering them in succession, until the last vestige of acid has disappeared. (Fig. 8.) As the gases are often exceedingly

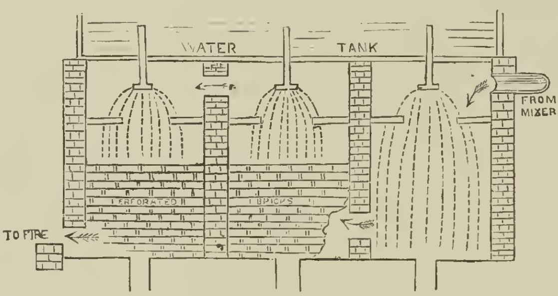

FIG. 8.—Condensing apparatus of Plymouth Chemical (superphosphates) Works. (After Ballard.)

hot, it is desirable to cool them to some extent before they enter the scrubber, for when the coke becomes heated, the condensation is very imperfect. Accordingly, they are generally made to go for some distance through a horizontal flue before entering the condenser or scrubber. If the scrubbers afford so much resistance to the passage of the gases as to interfere with the draught, a blower may be used to propel or to draw the current through them. The condensed products have often a commercial value.

It is very doubtful if any apparatus, however perfect theoretically, will condense the entire gaseous product of a large factory. The chimneys should, therefore, always be very high, so that the little gas that does escape may be as much diluted as possible by the air before it reaches living things. Attempts have been made to condense the fumes of such works by simply passing them through flues so long and chimneys so high that the mere abstraction of heat might precipitate them without the use of other apparatus. But such attempts have usually been failures. In superphosphate-works, for example, the vapors evolved contain fluorine in the form of tetrafluoride of silicon, and the watery vapor given off is sufficient to decompose the whole of this salt into silica and hydrofluosilicic acid. There is also some arsenic in these fumes. Now, at Morris & Griffin's works, which manufacture 300 tons of superphosphates a week, the gases are passed through a flue with a cross-section six feet by four, and 250 feet long, to a chimney 235 feet high. The deposit of silica is so enormous that it has to be removed about once in six weeks, and is sometimes found to be two feet deep. And still the works create a nuisance, and at a greater distance than before. (Ballard: Op. cit., p. 269.) It has been found in other works that an efficient scrubber will retain all the fluorine compounds and the sulphuric acid, but more or less arsenic will inevitably escape.

With regard to special works, a few words may be said. In the manufacture of ammonia and ammonium sulphate from gas liquor, the refuse liquid, containing considerable sulphuretted hydrogen, is run off into the sewer, or directly into a running stream. Care should be taken to have all the drains tight, and it is better that such works be at a distance from inhabited dwellings. The acid drainage of other factories should not be discharged into the same sewer with the ammoniacal liquor, as the decomposition of the remaining ammonium sulphide evolves immense quantities of sulphuretted hydrogen. The pollution of streams from this and other similar sources will be treated of elsewhere.

In alkali-works, condensers and scrubbers are used, with high chimneys. In superphosphate-works, two sets of apparatus are needed for the two distinct branches of business, viz., the preparation of the materials for manure, and the making of the manure itself. All offensive substances, as offal and blood, should be brought to the works in tightly closed receptacles, and cooked in steam-tight tanks. The vapors from the tanks and driers should be passed through a condenser, to rid them of all watery constituents, and then forced into the furnace fire and consumed. The mixing should be done in close vats, and the gases given off conducted to scrubbers, and thence to a high chimney.

Glass-works and potteries should have high chimneys, and be removed from the vicinity of dwellings.

In bleaching-works, the boxes in which the cloths and other materials are exposed to the gases should be made as tight as possible, and the fumes afterward condensed. The hydrochloric acid fumes from brick-works may be done away with by giving up the use of "breeze," but the

kilns evolve in addition enormous volumes of carbonic anhydride, carbonic oxide, and sulphurous fumes, which are injurious to vegetation, and not easily disposed of. Such kilns should, therefore, only be allowed in localities where no damage can be done by them. In France, a brick-kiln is not permitted within 50 metres of a public road; it must be covered with matting or other material to control somewhat the escape of fumes; must not be located near a garden or nursery, and can only be fired at night.

In copper-smelting works, the sulphurous acid fumes, by proper apparatus, may be retained and converted into sulphuric acid. Such apparatus is expensive, however, and the results do not pay for the cost and trouble. If condensing apparatus is not used, such works must be so located as to do the least possible damage.

In the other works mentioned, the gases may all be saved, and often with profit.

3. *Those processes which are offensive on account of the dust caused by them.*

In the businesses mentioned under this heading the application of heat produces an evolution of gas and considerable smoke, but the principal nuisance to neighbors is caused by the clouds of dust, which fill the air for several hundred feet on every side of the works, and often cause much damage to furniture or merchantable goods.

Plaster-burning.—Gypsum, plaster-of-paris, or sulphate of lime, in order to be of use in the arts and trades, must be nearly or quite anhydrous. For plaster-casts, ceilings, and walls, for which it is principally used, it is of value because, when mixed with water and applied in the form of paste, the water gradually combines with the base and forms a dry, hard hydrate. To prepare it for these uses, it is burned or calcined, and the water it contains driven off, so that it becomes a dazzling white powder, so fine as to be almost a fluid. The lumps of gypsum are generally broken and ground in a mill before calcination, and both processes give rise to a great deal of dust, which chemically is harmless enough, but mechanically is a great annoyance.

Attempts have been made to catch the flying dust in wooden chambers built about the mills, but without much success. The powder is so light and fine, that it is almost as difficult to confine as a gas. It is possible that something might be accomplished by having the air drawn continually from the room by a blower and forced into a long horizontal flue to a tall chimney. The heavier dust would settle in the flue, whence it could be removed as often as necessary, and a considerable portion of the lighter dust might be precipitated in the chimney by a spray of water. An ordinary spray condenser would be choked up too soon to be of any use. Such arrangements as those proposed would probably be more expensive than the business warrants, and the only alternative seems to be to locate such mills and kilns in the country, and in places where no nuisance would be created.

Lime-burning.—The only lime-kilns likely to be established in a city

or town are those for burning shells, already spoken of. Where lime stone is burned, enormous amounts of carbonic acid are given off, with a considerable quantity of dust, both together creating a nuisance sufficient to warrant the interference of local authorities. The only remedy is removal to a distance from dwellings.

Coffee-roasting.—Where coffee is roasted on a large scale, the beans are put into iron cylinders which revolve slowly over a hot fire, their contents being constantly stirred by rods in the interior. When the beans are sufficiently brown, they are removed, but as the chemical changes which bring out the aroma would proceed too far if the hot beans were allowed to cool slowly in bulk, they are put in a trough with a perforated bottom, through which a constant current of cold air is forced by a blower. This blast of air not only cools the coffee, but it blows out all the chaff and dust, which fill the air of the room, and passing out, constitute a great nuisance to neighbors. I have known these husks to be carried 200 or 300 feet in sufficient quantity to rouse vigorous complaints. The aroma of the burnt coffee and the smoke are rarely a subject of protest.

The apparatus for cooling the beans should be so arranged that all or most of the dust and chaff will be carried up through a large ventilating shaft to the top of the building. This can be done without inducing a current of air artificially, as the heat of such establishments is ample to keep up a constant draught. The top of this shaft may be covered with a large hood of wire netting, with meshes of about $\frac{1}{8}$ inch, reaching considerably below its top, or even fastened to the roof around it. It is better if this netting forms a sort of chamber, with considerable room for the free play of air currents, otherwise the chaff will be driven against the meshes and held there, and after a time interfere with the draught. Such an apparatus does not entirely abate the nuisance, but it greatly diminishes it, and the chaff may be shoveled up frequently and used as fuel.

Recapitulation.

Offensive processes, therefore, give rise to a public nuisance principally in these ways:

1. By the use and storage of offensive substances.

2. By the production of offensive, irritating or destructive vapors and gases.

3. By the discharge of great quantities of dust.

And the principal means at our command for abating these nuisances are:

1. Conveying and storing in tight vessels.

2. Forcing the gases through purifiers, condensers, and scrubbers, so as to fix the condensable ones, and then passing the combustible ones into the furnace fire.

3. The use of high chimneys and long horizontal flues, with sometimes a spray of water.

4. Removal from the vicinity of dwellings.

III.—Other Nuisances.

Under this heading are included several subjects of differing importance, which it is impossible to classify by any other common characteristic than the general one of obnoxiousness.

1. *Those nuisances which are nuisances on account of their offensive smell.*

a. *Dead Bodies.*

The amount of moisture in the bodies of animals and the instability of the organic substances of which they are largely composed, render putrefactive changes very rapid. Immense volumes of ill-smelling gases are given off, containing, according to Hirt, carburetted hydrogen, ammonia, nitrogen, sulphuretted hydrogen, with trimethylamin, tauryl, butyric and propionic acids, etc. Besides these gaseous substances, a certain amount of volatile organic matter is diffused in the surrounding atmosphere, which is deposited in greasy layers on neighboring things, and which can be tasted as well as smelt. These various products of decomposition are not only very offensive, but exercise a perceptible injurious influence on the health. Troubles of the digestive organs and intestinal fluxes attributable solely to the inhalation of such matters are familiar experiences of every medical man, while the actual introduction of putrefying animal matter into the circulation has been a frequent cause of disease and death to persons who handle dead bodies.

The disposal of the dead must, therefore, have been a very early problem in the history of the human race. And singularly enough, while the utilization of the remains of animals in such a manner as to render them innocuous has been for some time an accomplished fact, the proper disposal of human dead is still an open question.

Human bodies.—The ways of getting rid of the nuisance caused by dead bodies may all be classified under three heads:

1. Removal of the body to a place where it no longer constitutes a nuisance.
2. Its permanent preservation.
3. Its prompt and complete destruction.

1. *Removal of the body.*

The first of these methods is undoubtedly the oldest, and probably its first form was that of simple exposure. The dead body was removed to a distant locality and left exposed to the beating of the wind and rain, and to the assaults of wild beasts. In some respects this may be considered the natural method of disposing of the dead. The plant rots where it dies, and furnishes material for the sustenance of others. Why not the animal also? As soon as sentimental or religious considerations began to influence the actions of men, they took measures to protect the corpse

from wild animals, and we find many ancient tribes, and some of our own time, exposing the bodies of their dead on raised platforms, where they were still, however, the prey of birds. Some of our Western Indians put their dead, even now, on platforms raised on tall poles, and the Colchians and Phrygians are said to have hung their dead to the limbs of trees. These practices, after a time, gave way to the custom of placing the dead in caves, and sealing up the mouth. In this way the bodies were protected from the action of any destructive forces excepting chemical ones. Many of these cave sepulchres have been recently discovered. From this it was but a step to the construction of artificial tombs, either in the form of stone chambers, or of simple holes dug in the earth, into which the body was placed and covered up. This, one of the most ancient ways of disposing of the dead, has maintained its ground to the present day. It is evident that the method of exposure is not permissible for civilized nations. Aside from the shock to sentiment, it is only suitable for thinly-settled countries, or for nomadic tribes. Near permanent populations, it would soon cause a pestilence.

Among maritime nations, sea burial has been practised. It is even now the custom to commit the bodies of those who die on shipboard to the water, and this will always be necessary for the protection of the survivors. There are many objections to adopting it universally. Notwithstanding heavy weights, the bodies might sometimes be set free by the vigorous assaults of the larger fish and be cast upon the shore in fragments. When single bodies are thus disposed of, and that generally at a great distance from the shore, there is no danger of this. But the dead of large cities could not be carried far out to sea on account of the expense, and when burials took place in a single locality at the rate of one hundred a day, there would certainly be some risk of a nuisance like the one suggested. Moreover, the inhabitants of towns along the shore are great eaters of fish and crustaceans, and it would surely not be agreeable to any one to think that they were all fattened on human flesh. For inland nations this method is evidently impracticable on account of expense.

Burial in the earth is then the only method under the first heading capable of extensive application. As a matter of convenience in handling, and to some extent of sentimental reverence for the dead, as well as in deference to long-established custom, the body is placed in a box, often made of precious wood and highly ornamented, both outside and inside. This box, with its contents, is then either put in a hollow walled chamber underground, called a vault, or more commonly is simply sunk in the earth in immediate contact with the soil on all sides. Burial in tombs or vaults can never become general on account of the expense, and also because the space taken up by the dead would soon crowd out the living from any populous region.

Burial should not take place with undue haste. Although there are many apocryphal cases of burying alive reported, there are some undoubtedly genuine. The distortion of features and change of posture in bodies, caused by the distending force of the gases of putrefaction, will not ac-

count for instances of bodies found inside the doors of vaults, with coffins broken open, and every indication of desperate struggles for escape. On the other hand, it is to be borne in mind that in Frankfort and Munich it has been the custom for many years to expose the dead as long as possible on biers surrounded with flowers, in a public place, with bell-wires or strings attached to their fingers, so that the slightest movement would summon an attendant. And yet there has never been an alarm sounded, nor a case of resuscitation. It would be safer, however, to defer burial until indications of decomposition have set in, the first being a greenish tinge of the surface of the abdomen over the cæcum.

It is important to bury the body so deep that the gases evolved from it will not poison the surrounding atmosphere. If it is placed in a vault, the opening should be hermetically sealed. This is generally effected by covering it with a flag-stone laid in cement. If it is buried in the earth, it is best to have at least six feet of soil above it. The depth required by law in different countries varies considerably. In England there must be at least four feet of soil above the body of an adult, and three above a child's. In France, according to Tardieu, graves must be 1 metre and 50 centimètres deep, and from 3 to 4 décimètres apart. Austria requires a depth of 6 feet, and that they be 4 feet wide and 4 feet apart. In Russia, graves are from 6 to 10 feet deep.

The character of the soil is also of importance. It should be such as to allow of the passage of gases and fluids in every direction. It should also contain a considerable amount of organic matter, vegetable mould, which seems to accelerate decomposition, and to act in some degree as an antiseptic. In Orfila's experiments, he found the decomposition was most rapid in a soil which he describes as a mould, with a strong proportion of vegetable detritus, and considerable silica and lime carbonate, and the process was most tardy in a soil consisting of quarry sand, silica, and ferruginous earth, with traces of mica and calcium carbonate. Soils containing lime salts are favorable ones, while clayey ground both retards decomposition and endangers the health of the neighbors by water-pollution. This subject will be treated of elsewhere.

The body of a person who has died of contagious disease is doubly infectious. It is a matter of frequent occurrence for such diseases to be contracted at funerals. It is desirable, therefore, to limit the attendance at such ceremonies as far as possible. Small-pox being virulently contagious, a public funeral of one who has died of it should under no circumstances be allowed. The practice in New York, insisted upon in every case by the Board of Health, is to wrap the body in cloths saturated with carbolic acid, and put it in a metallic coffin, which is hermetically sealed. And even then no funeral is permitted. It would certainly be well if the bodies of all those who have died of scarlatina, measles, and diphtheria were also buried in air-tight coffins.

It has been proposed to surround the coffin in the grave with a disinfectant, like charcoal, for instance. The suggestion has also been made that bodies should be encased in cement or artificial stone, and so be

rendered innocuous, even if kept above ground. The objection to this is, and it is a very strong one, that if these stone masses were buried, the cemetery could never be used again when it became full, and if they were kept above ground, they would soon form an immense accumulation of useless material, for which it would be difficult to find room. Supposing each body to occupy, with its plaster covering, a space of 6 feet long by $2\frac{1}{4}$ wide, and 2 deep, making a cubic yard, New York alone then would furnish every year nearly 30,000 cubic yards of stone for storage, or a mass $810 \times 100 \times 10$ feet. Moreover, badly-made cement might crumble, with disastrous consequences. And when it is considered that the gas from soil-pipes will pass through a cement joint, it might be expected that the gases of decomposition would be perceptible outside of these receptacles.

Believing that decomposition would be hastened, and the well-known antiseptic qualities of fresh earth would have better play, Mr. Seymour Haden has proposed the burial of bodies in wicker baskets, fitting the form approximately, and with large meshes, so that the soil would come in immediate contact with the body. The proposition seems to me a very sensible one, but I cannot learn that it has met with much favor. There seems to be no good objection to the plan, unless it be a sentimental one, and it is supposed that the dead lie warmer and more comfortable in coffins. Such feelings are to be respected, and will at any rate always carry their point.

It will be convenient to defer the consideration of the advantages and disadvantages of burial until we speak of cremation.

2. *Permanent Preservation of the Body.*

The practice of preserving the body so that it can be kept above ground is a very ancient one. The only nation that has made use of it when highly civilized is the Egyptian. Herodotus, in Euterpe, gives some curious details of the method they followed, which consisted in removing the viscera, and filling the cavity with nitrous substances and spices, and wrapping the body in cloths saturated with them. It is doubtful if the method they followed would have been successful in any but a very dry climate. At a temperature of 122° Fahrenheit, putrefaction ceases and desiccation takes place. In a hot sun, therefore, a body may be dried into a mummy, and in fact the Peruvians anciently preserved their dead in this way. It is said that some of the aborigines in Japan, and some of the tribes of India, follow similar methods.

In modern times and in civilized nations, embalming is only resorted to in special cases. It is often desirable to preserve the deceased for days or weeks, or even months, for purposes of identification, or for convenience of removal, or even to satisfy the affection of distant friends. Modern methods are many, but are mostly limited to the injection of chemical substances into the blood-vessels.

As a means of abating the nuisance caused by a dead body, embalm-

ing is useless. A mummy or an embalmed corpse always exhales an earthy, unpleasant odor, and if the practice should ever become general, the accumulation of bodies above ground would soon become frightfully large. As an incentive to remembrance of the dead, a mummy would certainly be a melancholy reminder of the friend whose body it represented. And still it has actually been proposed within a few years to revive the custom of embalming as a general practice!

3. *Prompt Destruction of the Body.*

The rapid destruction of dead bodies has often been brought about by burying them surrounded by substances that induce profound chemical changes in the tissues. Thus nitric or sulphuric acid may be used, or the coffin may be filled with caustic potash. Certain Jews in Northern Africa are said to bury their dead in quicklime, and people of the same race have recently used this method at Mile End Cemetery, in London (Eassie). Where large numbers of bodies have to be buried in a limited space, the latter plan is a good one, and has been successfully tried. At Metz, in 1870, a huge pit was dug seventeen feet deep; a row of bodies was placed at the bottom, side by side; then a row on top of them, with the heads lying at the feet of the first row; the third row was laid across, and the fourth also, with the heads by the feet of those in the third row; the fifth row lay in the same direction as the first, and so on. Between the layers about an inch of powdered lime was thrown. In this manner from ninety to one hundred bodies were buried within a length of six and a half feet, reaching to within six feet of the surface. The pit was then filled with earth, and, although it contained 8,400 bodies, there were no perceptible emanations from it (Parkes). The same plan tried during the Prussian occupation of Chalons, however, gave less satisfactory results, and the drinking-water in the vicinity was contaminated.

The only widely used method of destroying bodies is to burn them. The list of nations in which cremation has been the customary way of disposing of the dead is a very long one, including the Greeks and Romans, many of the ancient tribes of Europe and Asia, and at the present day the East Indians, and some Indian tribes in North and South America. In all these cases the body is burned on a pyre in the open air, and the process is a very objectionable one, requiring, as it does, a long time for its accomplishment, an enormous mass of fuel, and creating an intolerable stench, which has to be smothered with the aroma of spices, where the relatives can afford it. Moreover, the burning is often imperfectly done, the heat attainable in this way being insufficient to calcine the remains.

Of late the question of cremation has been revived. Epidemics and sporadic cases of disease due to the infection from cemeteries, together with the crowded condition of the latter, and the increasing difficulty of finding room for the dead of the gigantic modern cities, have made this problem of the proper disposition of the dead a matter of immense sanitary

importance. With modern scientific appliances, a human body can be reduced in a very short time to a handful of clean white ashes, at an incredibly small expense. The Siemens apparatus used in Germany affords a good illustration of this. It is constructed on the principle of the Bunsen burner, and the body is subjected to the exceedingly hot flame produced by the mixture of gaseous hydrocarbons and air. By means of this apparatus Sir Henry Thompson saw a body weighing 227 pounds, and not emaciated, reduced to 5 pounds of ashes in 55 minutes; and at Dresden, a horse weighing 460 pounds was reduced in 4 hours to 23 pounds of ashes, at a cost for fuel of only 4 shillings (Eassie). The process of destruction is attended with no escape of offensive gases, and can in no way give rise to any nuisance. The details of the commission of the body to the flames can easily be arranged so as not to offend the most fastidious affection. The furnace may be entirely out of the sight of the mourners, and the room in which the final religious rites are performed may only be connected with it by a small opening for the reception of the remains. This may either be a door in the wall, into which the body is slid with its wrappings, or a hole in the floor, through which the remains are lowered as if into a grave. The ashes can then be preserved without the slightest danger that the public health will suffer thereby.

It is plain without argument that a complete destruction of the body by these modern methods is, in a sanitary point of view, far preferable to burial. But the latter method has the sanction of ancient usage, and is so intimately connected with the sentimental and religious feelings of the public, that cremation will make its way into general favor very slowly. To be sure, the difficulty of gathering up ashes at the general resurrection has been put forth gravely as an argument against the cremation of Christians (!), but the mind that can believe the Divine power in danger of being thwarted by such cheap human devices can only be looked upon as a psychological curiosity, and the real objection of most people to the practice is an emotional phenomenon, and therefore the harder to reach by argument. It is altogether probable that if bodies were usually burned, and burial were proposed as a substitute, there would be an outcry of horror at the barbarous suggestion.

The real advantages of burial as compared with cremation are two in number. If a body is buried, it can be exhumed for the purpose: 1, of recognition in cases of doubtful identity; and 2, of examination when poisoning is suspected. The impossibility of doing this when the body has been reduced to its elements is the gravest objection to cremation. And still, if cremation were ever to become a general custom, as it is to be hoped it will, man's ingenuity will doubtless find some way of meeting and conquering the difficulty. In the first class of cases, those of doubtful identity, the objection might perhaps be got over by separating dead bodies into two classes, burning those whose identity is beyond cavil, and burying those that are unknown. As to the second class of cases, hardly any poisons can be recognized in a body much decomposed, excepting the metallic ones, and some arrangement might be made by which the pres-

ence of arsenic or antimony, for example, could be automatically detected in the gases escaping from the chimney, as they would certainly be volatilized. These difficulties might also be got over by having professional corpse-viewers, as is the custom in France, who should examine into the cause of death and the identity of the corpse in every case.

Lower animals.—It is a little curious that the different ways of disposing of the human dead have also been applied to animals. Their bodies have been exposed, embalmed, buried, and burned, and finally, after having always been treated as a nuisance to be got rid of, they are now utilized in the manufacture of artificial manures, as before explained. Although the successive methods of disposing of human remains have continually reduced the nuisance, it being in cremation brought to its minimum, it is not probable that the only remaining step will ever be taken, viz.: that of utilizing the dead as fertilizers, or in the manufacture of illuminating gas, as has been suggested in France.

b. *Gases of Decomposition.*

It is one of the great problems of our time to decide upon the best method of protecting the community from the dangers and discomforts caused by the gases given off from decomposing human excreta and household slops. Elaborate systems of drainage and ventilation have been devised, but the continual stream of new inventions and novel appliances of old is a sufficient proof that the end has not yet been attained. These gases contain ammonium sulphide, sulphuretted and carburetted hydrogen, ammonia, nitrogen, carbonic acid, and undetermined organic matters. Many of these constituents are poisonous in a concentrated form, and there is sufficient evidence to show that, even when considerably diluted, they seriously undermine the physical vigor of those who are constantly exposed to them. Moreover, it is yet uncertain how far such matters may serve as a nidus for the development of microscopic organisms, the mere suspicion of which strikes such terror into the modern mind. The sources from which such gases may spread into adjoining premises may therefore be fairly classed as public nuisances.

Privy-vaults.—In the country, where privy-vaults are at a distance from the house, they rarely, if ever, constitute a nuisance either public or private. But in the city the nuisance caused by them is often disagreeable and dangerous. In the most populous districts of New York, for instance, the tenement-houses, containing from eight to thirty families, are built on the front and rear of the lots, with a yard between them. In this yard is located the privy-vault, and into the vault is discharged through leaders the rain-water from the roofs, while a sewer-connection eight or ten inches from the bottom of the vault is expected to carry off the fluid contents. This sewer-opening becomes frequently obstructed, and, as the vault receives a large amount of water, its contents decompose rapidly. During a rain the rush of water from the leaders stirs up the water in the vault and liberates an immense amount of gas held in solution. Under such circumstances a vault is a terrible nuisance.

This condition of things can be remedied to some extent by a careful and thorough use of disinfectants. (See "Disinfectants.") In New York, the Board of Health sees that this is done during the summer months, when the nuisance is most dangerous. A considerable part of the foul gases may also be carried off by means of a shaft from the vault to a point a foot or two above the roof of the adjoining buildings. Every privy-vault in New York is required by the Sanitary Code to have such a shaft, which is generally made of galvanized iron and is at least eight inches in diameter. If the shaft alone is not efficient, a revolving ventilator may be placed on top of it, so as to maintain a constant upward current of air.

Ventilating-shafts and -pipes.—The gases which are discharged from the top of the ventilating-shafts of privy-vaults and the extended soil- and waste-pipes of dwelling-houses are sometimes a nuisance to the occupants of adjacent higher buildings. Although, as a rule, there are no windows in the sides of buildings looking out upon the neighboring premises, still there are such sometimes, and gases from such a source may even be blown into the front or rear windows. The ventilating-pipes may also pass through the roof near a skylight, and occasionally the gases be thus drawn down into the house. It must be confessed, however, that any nuisance from these pipes is very uncommon, as the gases are very quickly diluted with air so as to be unappreciable. I have found the odor from a three-inch ventilating-pipe impossible of detection at a distance of ten feet, when within two feet it was insupportable.

If such a pipe, however, does become a nuisance, the gases must be disinfected before they emerge from it. The only practicable method of accomplishing this is to make them pass over or through charcoal. The charcoal may be spread upon shelves arranged alternately like those in a gas-purifier (Fig. 9), or it may be put upon a spiral tray, as recommended by Latham (Fig. 10). The trays should have wire bottoms, so that the

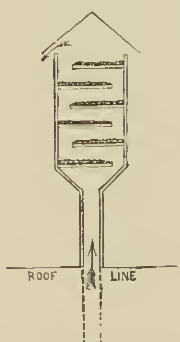

Fig. 9.—Disinfecting apparatus for ventilating-pipes.

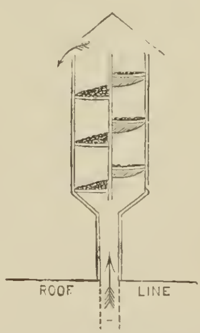

Fig. 10.—Latham's disinfecting-tray (spiral) for ventilating-pipes.

current of air and gas will impinge upon the under as well as the upper side of the disinfecting material, and the charcoal should be broken into lumps about as large as filberts. The disinfectant had better be put at

the top of the pipe rather than lower down, as moisture injures the efficacy of the charcoal. A sheet of charcoal with numerous perforations might also be put in the pipe transversely, filling its calibre. As all these methods involve some friction at a point where it is particularly desirable to have free passage for the gas, it may be necessary to assist the current by means of a revolving ventilating-cap.

Sewer-openings.—The openings of the receiving-basins at street-corners are not usually the cause of any nuisance, as the basins are fully trapped; but the man-holes in the streets are not trapped, as it is necessary to have some points of relief when there is an extra pressure of gas in the sewer, as during a heavy rain. Although, as a rule, these man-holes being in the centre of the street, there is no perceptible odor from them excepting in their immediate vicinity, they do sometimes cause an appreciable nuisance. If it is thought proper to disinfect such openings, it may be done by an arrangement of charcoal trays similar to those described above. The matter of the ventilation of sewers will be discussed elsewhere.

Street-gutters.—The gutters receiving the entire surface drainage, as well as slops from houses which are not connected with the street-sewer, require special attention, particularly in hot weather. They ought to be washed daily, and frequently disinfected.

2. *Those nuisances which are nuisances on account of the danger of infection connected with them.*

Cemeteries.—The putrefaction of a great number of bodies in one place, even though many feet under ground, has been proved by experience to often cause a serious nuisance. When the yellow fever visited New York in 1822, the mortality was great, and the attacks of the disease frequent and persistent in the vicinity of Trinity church-yard. It is stated that the place was crowded with bodies, in some cases only covered with eighteen inches of earth. There was a perceptible smell from this yard, and it was covered with quick-lime, some of the laborers engaged in spreading it being forced to vomit by the stench. It has been said, in a report of the French Academy of Medicine, that diphtheritic diseases have raged in the vicinity of Père-la-Chaise, Montmartre, and Montparnasse, attributed to the putrid emanations from these cemeteries. Professor Selmi, of Mantua, has discovered in the stratum of air which has remained for a certain period over a cemetery during a time of calm, organisms which considerably vitiate the atmosphere and are dangerous to life. When the matter in question was injected under the skin of a pigeon, a typhus-like ailment was produced, and death ensued on the third day (Dr. De Pietra Santa, quoted by Eassie on "Cremation"). It has already been mentioned above that the best soil for graveyards, and that which insures the most rapid destruction of the bodies, is a light, porous one, which allows of the passage of gas and liquids. This soil is also naturally the most dangerous, for it allows the putrid emanations to escape and surface water to percolate through it. It is stated by Eassie

that in a churchyard in Stuttgart, in which only 500 bodies were interred yearly, and not more than one in each grave, the northwest wind rendered the emanations from the dead perceptible in houses 250 paces distant. Many persons in France and England have said that they saw, on damp, mild days, especially in the early morning, a thick visible vapor over graves, very nauseous to the smell, so that their windows had to be closed. There does not seem to be much evidence, however, that the pollution of the atmosphere by cemeteries has ever caused much sickness, and the instances where such pollution has occurred have been mainly where the bodies were insufficiently covered with earth.

The exhumation of bodies, however, often gives rise to serious trouble. Even newly dug graves sometimes rapidly fill with carbonic acid, which flows in from the surrounding soil (Eassie). The danger of exhumation is greatest when old cemeteries are dug over for other uses, or a large number of bodies are taken up for transportation. Eassie gives many examples of this. The reappearance of the plague at Modena, in 1828, is said to have been due to an excavation made in some ground where the victims of the plague had been interred 300 years before. The excavations made for sewers in the site where the victims of the plague of 1665 were buried increased the virulence of the cholera in London in 1854. The authorities had been warned of this probable result by Mr. Simon. Dr. Playfair believes that the fever prevalent in Rome is due to the exhalations from the soil, which is saturated with organic matter. "In 1843, when the parish church of Minchinhampton was rebuilding, the soil of the burial-ground, or what was superfluous, was disposed of for manure, and deposited in many of the neighboring gardens. The result was that the town was nearly decimated." (Eassie: Op. cit., p. 7.) Tardieu states that in 1830, at the Marché des Innocents, on the site of an old cemetery, temporary burials were made, and a ditch was dug 12 feet by 7, and 10 feet deep. When the pavement was removed and about six inches of sand beneath it, they came upon a black, greasy soil, filled with bones and pieces of coffins, and exhaling such fetid odors that one of the workmen was suddenly suffocated. At Riom, in Auvergne, the earth of an ancient cemetery was dug up to embellish the city. A little while after an epidemic occurred, which carried off a great number of persons, and was most fatal near the cemetery. The same thing caused an epidemic, six years before, in a small town of the same province, called Embert.

On the other hand, it has been remarked by Parent-Duchâtelet that there are about 200 exhumations annually at Père-la-Chaise, at all times of the year, and from two to four months after death; yet no accident occurs to the diggers. And Tardieu states that the exhumations from the cemetery and church of the Holy Innocents, at Paris, in 1785–6, lasted six months, and from 15,000 to 20,000 dead bodies of all epochs were taken out with their coffins. All degrees of destruction were seen, from the body dissolved and putrefied to dry, fibrous mummies. Yet no accident occurred among the workmen nor in the neighborhood. In 1874 the

Massachusetts Board of Health sent out queries to nearly 500 physicians in different parts of the country, requesting their opinions regarding the influence of cemeteries on the public health, and on the pollution of air and water by them. The results of the investigation are given by Dr. Adams in the Report of the State Board of Health for 1875, and the conclusion reached was that, in this country at least, no evil results could be traced to the practice of burial in graveyards.

These facts are enough to show that the evidence with regard to the noxiousness of cemeteries does not all point one way. Their apparent conflict may perhaps be to some extent explained by supposing that, in cases where a pestilence has resulted from the opening of an old cemetery, the bodies had been too much crowded, and buried with too little soil above them. These conditions have certainly existed in very many of the frequently quoted instances. Where the victims of epidemics have been buried, it must be considered dangerous to dig them up without thorough disinfection and the greatest precaution. It is impossible for any one to say how long the materies morbi may continue to live under ground. Certainly, if organic matter can be boiled and frozen without losing vitality, and seeds 3,000 years old will sprout when planted, it would be hardihood to assert that the poison of cholera or small-pox, whatever it is, may not lie for many years dormant, but not dead, in the moisture and equable temperature of the grave.

The lapse of time which ought to be allowed before a grave is used for another body varies, of course, with the nature of the soil and the method of burial. The estimates which have been made of the time required for the complete destruction of a body vary between 40 and 3 years. Gmelin puts it at 30 to 40 years; Wildberg at 30; Frank at 24 to 25; Walker at 7; Tyler at 14; Tagg, proprietor of a London cemetery, 12; Maret, 3. Orfila found bodies reduced to skeletons at the end of 14 or 18 months, even in coffins (Tardieu). Correspondingly variable are the times fixed by law during which bodies must not be disturbed. Tardieu gives the following limits: Hesse-Darmstadt, 30 years; Prussia, 30; Sigmaringen, 20 to 25; Frankfort-on-the-Main, 20; Wurtemberg, 18; Leipsic, 15; Milan, 10; Stuttgart, 10; Munich, 9; and France, 5.

The pollution of water by cemeteries will be considered elsewhere.

In order to provide against any possible danger from buried bodies, cemeteries should always be located at a distance from dwellings. In almost all civilized countries it is now the practice to bury the dead outside the city limits. The proper soil and the method of burial have been already spoken of under "Dead Bodies." The true way of abolishing forever the nuisance of cemeteries is to burn the dead, and either to strew their ashes over the fields, as suggested by Sir Henry Thompson, or preserve them in columbaria.

When bodies are to be exhumed, proper precautions should be taken against possible dangers. The fatal cases of persons exposed to graveyard effluvia seem to have been due to the inhalation of carbonic acid or sulphuretted hydrogen. The earth which is infiltrated with organic matter,

and the remains themselves, should therefore be sprinkled with chloride of lime, and as far as possible such work should only be done in cold weather. Tardieu recommends the use of long-handled tools, so that the men can work without stooping so much in the excavation.

Prostitutes.—The main reason for classing prostitutes as public nuisances is that they are the chief agents in the propagation of venereal disease. This part of the subject will be treated of in another chapter, and it only remains for me to say a few words on the minor degrees of nuisance connected with prostitution.

Prostitutes undoubtedly do great harm by inveigling green boys and youths to their embraces. They are always well acquainted with the ways of the world, as well as with its vices, and by long association with men, in addition to their native feminine tact, have acquired the arts by which the average male is fascinated in a degree not always possessed by the more modest of their sex. When one of these women seizes upon a youth at the most susceptible period of his life, he is very apt to become so infatuated with her charms as to be led into actual crime to gratify her desires. The consequences of such an entanglement may be very far-reaching, and involve innocent persons in great distress.

The sight of prostitutes plying their trade is not a pleasant one for decent women, and still it is a nuisance existing to a greater or less degree in all large towns.

Prostitution can never be abolished, nor is it desirable that it should be. It is as certain as anything can be in this world, that if it were abolished, something worse would take its place. Marriage depends too much upon the price of corn to be much affected either way, and the sexual passion would, in a large number of men, find its gratification in some other way than that. The only question then is that of confining prostitution within proper limits. To prevent as far as possible the seduction of youth who might otherwise remain chaste for a time, and to prevent any shock to the sensibilities of modest women, stringent laws should be passed and enforced against the solicitation of men by prostitutes. Men should seek these women, and not be sought by them. Every prostitute should be obliged, under fear of a severe penalty, to conduct herself in public places like a virtuous woman. Further than this it does not seem advisable for the law to go, excepting for the purpose of preventing contagion.

Diseased animals.—The diseases which are liable to be communicated from animals to men are *glanders*, *farcy*, and *hydrophobia*. The two former diseases affect the horse and its congeners, and the latter the dog and some other carnivorous animals (foxes, wolves, cats, martens, and badgers).

Glanders and *farcy* are essentially the same disease—that is, they are both produced by the same poison. They are intensely contagious, and may be either acute or chronic. The inoculation of the specific virus in one animal may produce acute glanders, in another farcy, and in a third chronic glanders. It is not positively known whether the disease ever

originates spontaneously, or whether it is communicable through the air, but in the vast majority of cases it is undoubtedly communicated by direct contact.

In *glanders* the most prominent symptom is the affection of the nasal mucous membrane. If the disease is chronic, the general health of the animal may not suffer at first. There is some swelling of the submaxillary lymphatic glands, and a discharge from one or both nostrils, generally from only one—at first watery, afterwards becoming purulent, bloody, and fetid. There are ulcerations on the mucous membrane, and acute glanders is often developed, and carries the animal off.

In *acute glanders* the discharge from the nostrils is accompanied by a high fever, with cough and shortness of breath, and the ulcerations are deep and extensive.

Chronic farcy commences by an indolent inflammation of the lymphatic glands and vessels, which become red, tender, and enlarged. There is also an eruption of cutaneous tumors. The glands and tumors tend to suppurate and form indolent ulcers, which discharge an ichorous fluid. The general health may remain good for some time, but at length emaciation sets in, with cough, and often acute symptoms, with which the animal dies.

In *acute farcy* the symptoms are more urgent, and the abscesses take on an inflammatory character.

The morbid anatomy of all these forms is the same, including injection, swelling and ulceration of the nasal mucous membrane, and lobular pneumonia.

It was not known that these diseases were communicable to man until Schilling reported a case in 1821, under the title "Merkwürdige Krankheit und Sectionsgeschichte einer wahrscheinlich durch Uebertragung eines thierischen Giftes erzeugten Brandrose." Since that time many cases have been reported, and the fact of its communicability is so well established that in most countries laws have been enacted to prevent the spread of the disease among horses as well as to men.

As the nasal secretion and the discharges from all sores and ulcers of glandered horses are intensely contagious, it is of the utmost necessity to get the sick animal out of the way as soon as possible. It should be killed, and although it is seldom practicable, it would be well if the body were burned. All hay, straw, bedding, etc., which could possibly have been touched by the animal, should be burned, blankets, etc., fumigated with sulphur, and the wood-work of his stall scraped and washed with a strong solution of carbolic acid. In order to have all necessary precautions properly observed, the Sanitary Code of New York City provides (Sec. 185): "That every veterinary surgeon who is called to examine or professionally attend any animal within the city of New York having the glanders or farcy, or any contagious disease, shall within twenty-four hours thereafter report in writing to the Board of Health of such city the following facts, viz.: 1st, a statement of the location of such diseased animals; 2d, the name and address of the owner thereof; 3d, the type and

character of the disease;" and Sec. 121 provides that no animal with glanders or farcy, or any contagious disease, shall be in any way disposed of, excepting with the permission and under the direction of the Board of Health.

Hydrophobia occurs in dogs with sufficient frequency to render its prophylaxis a matter of importance. It is caused by the inoculation of a specific poison, according to Youatt and Gamgee, and never originates spontaneously, even in animals. Hammond has expressed an opinion that it may sometimes be communicated by the bite of a healthy animal, but such a theory would require a stupendous amount of proof for its support. The virus seems to exist in the saliva alone, and so the disease is usually communicated by the bite.

A dog attacked with rabies is restless, dull, and evidently shuns the light. The pupils are dilated, and the well-known bark is changed into a melancholy howl. Sometimes there is delirium, and the dog snaps at imaginary objects in the air. The appetite is lost, but there is often considerable thirst, and the animal usually drinks without difficulty. Saliva dribbles from the tongue and sides of the mouth, and emaciation, with marked retraction of the abdomen, sets in. There is constipation, with a scanty discharge of urine, and often a morbid craving for filth, so that the animals will eat dung, portions of dead dogs, etc. The disease lasts from four to eight days, and toward the end the animal is often paralyzed in his hind-quarters. It is always fatal.

The chief points in the prophylaxis of hydrophobia are to kill every mad dog, and to keep every dog that has been bitten by another under strict surveillance, and kill him as soon as he becomes sick. The only exception to be made to these rules is when a human being has been bitten by a dog supposed to be rabid. In such cases the animal should not be immediately killed, but should be confined until the true nature of the disease is beyond doubt; for if the animal should recover, it would relieve the bitten person from terrible anxiety. The New York Sanitary Code makes essentially these provisions, and adds that "the dead body of any animal that died of such disease shall be at once buried not less than three feet under ground, at some place not within 1,000 feet of any residence." It would perhaps be better to have them burned.

The diseases of food animals are considered elsewhere.

3. *Those nuisances which are nuisances on account of their dangerousness.*

Every year persons are killed or injured by preventable accidents, and many of these accidents are due to the carelessness, greed, or parsimony of individuals, who, in one way or another, render their premises a source of danger to the lives and limbs of others. The most common nuisances of this class are unprotected stairways and areas, uncovered cellar approaches, unguarded excavations, buildings in course of erection, swinging signs, imperfectly fastened flag-staffs and poles, insecure chimneys, and ferocious animals.

It is the duty of the public authorities to see that all depressions below the level of the street, roadway, or sidewalk, into which a passenger may slip or step, are properly protected, either by railings, fences, or close covers. Openings in the roadway should have an additional protection at night by means of lights.

Where new buildings are erecting, there is a certain amount of danger from falling tools, bricks, and pieces of lumber. The dangerous locality should either be protected by a temporary shed, with a roof over the sidewalk made of plank thick enough to resist the impact of anything likely to fall upon it, or the public may be prevented from passing within a certain distance by fences, or, as is the custom in Paris, by men stationed to warn them away.

Swinging signs, and signs which stretch over the sidewalk, should never be allowed; and a penalty should be enforced against the owner of any building from which falling bricks or stones, etc., injure any passer-by.

The laws relating to ferocious animals ought to be exceedingly stringent. Dogs that are known to be cross should be kept in confinement when on their master's premises, and when taken out should be properly muzzled. Cross cattle and biting or kicking horses should also be kept under strict surveillance, and their owners held responsible for any damage done by them. Biting horses should certainly always be muzzled.

4. *Those nuisances which are nuisances on account of the smoke caused by them.*

Among the unpleasant results of the immense development of manufactures in modern times is the discharge of enormous volumes of smoke into the atmosphere, defiling the face of nature and causing great inconvenience and discomfort to human beings. All factories in which large fires are kept are more or less of a nuisance in this respect; but the establishments against which complaints are most frequently made, in my experience, are box factories, planing-mills, founderies, forges, potteries, dye-houses, sugar refineries, and breweries.

The composition of smoke, as it leaves the chimney, depends largely upon the character of the fuel used. The visible portion of it is unconsumed carbon, but there are also various acid products of combustion, beside the normal constituents of the air and some water. According to Parkes, anthracite coal smoke adds to the air carbonic anhydride, carbonic oxide, hydrogen, carburetted and sulphuretted hydrogen, nitrogen, water, carbon, and sulphuric acid. Angus Smith found in the black smoke of a sugar refinery, of carbonic acid 7.13 parts, of carbonic oxide .52 parts, of oxygen 12.93 parts, and of nitrogen 79.42 parts, besides water, soot, and sulphurous acid. In common smoke he found 2.53 parts of carbonic acid, 18.61 of oxygen, and 78.86 of nitrogen. The chief nuisance caused by smoke is due to the unconsumed particles of carbon.

The amount of carbon which escapes in smoke depends on the charac-

ter of the fuel used, and also on the way in which it is added to the fire. The unconsumed carbon is of course that which has either never been heated to the point at which it combines with oxygen, or, if so heated, has not come in contact with oxygen. The former is generally the case, and the failure to attain the proper temperature may be due to any one of many causes. In order to keep up a fire there must be a constant supply of fresh air, and that from which the oxygen has already been taken must be withdrawn. This continual and rapid change of the air in contact with the heated substances is brought about by the difference in weight of heated and cold air, and constitutes what is called the draught of the furnace. Now, if the fuel used be light and porous in texture, if particles are easily detached from it, the disintegration which begins when it is heated to a certain point even short of ignition, will result in the whirling away of small particles and even cinders in the air-current before they are consumed. Accordingly the use of shavings, sawdust, and splinters of wood for fuel produces heavy clouds of smoke, and the box factories and planing-mills, which consume their waste both to get rid of it and to economize in coal, are the objects of frequent complaints. Bituminous coal also causes a thick black smoke, and as this is the coal generally used in England, the smoke nuisance is a more common one there than here. Anthracite coal, on the other hand, being hard and coherent, and consuming slowly at a red heat, produces very little smoke, and rarely gives rise to a nuisance unless the sulphurous gases from it are plentiful enough to be noticed. Wood, being a soft, not closely knit fuel, also causes some smoke; and if it be green, the water of the sap absorbs so much heat during its conversion into steam, that considerable of the carbon escapes unconsumed. The method of firing also has its influence in the production of smoke. If the fresh coal is spread over the entire surface of that already heated, the sudden cooling of the upper layer produces an abundant evolution of smoke. A too abundant and a too scanty supply of air produce the same effect. If the supply is too abundant, a portion of the coal is cooled sufficiently to give off smoke; and if it is too scanty, some of the carbon has no opportunity of combining with oxygen, and so passes off as soot.

The prevalence of smoke in the atmosphere does not seem to produce any injurious effect upon the public health. The yearly mortality of England, which suffers more than any other country from the smoke nuisance, is very low, being in London, for instance, only about 22 in 1,000, and in the great manufacturing town of Manchester, only 28 in 1,000. In Pittsburg, Penn., where bituminous coal is used, and the smoke nuisance exists in a high degree, the annual mortality is only 26 or 27 per 1,000, which is not high, considering the large factory population. But a large amount of smoke in the air does appreciably affect the comfort of those who have to inhale it. If it is very dense, it produces some irritation of the throat and sometimes a feeling of dryness, with a tickling cough. It may also cause smarting of the eyes, and increased vascularity of the conjunctiva, with lachrymation. This is more likely to be the case with

wood-smoke than with coal-smoke, probably owing to the presence of pyroligneous acid or other acid products of destructive distillation. The smoke of isolated factories is not always a nuisance, for in fine weather it usually rises and is so dissipated in the air that it is not perceived anywhere offensively. But in damp weather, and when the barometric pressure is light, it sinks to the ground in the immediate vicinity of the chimney, to the great discomfort of those who live near by. The meteorological conditions affect the gaseous products of combustion, of course, as well as the carbon, and the air of a manufacturing town is at times therefore much richer in carbonic acid than at others. Angus Smith found on a foggy day in Manchester .0679 per cent. of carbonic acid in the air, and in ordinary weather only .0403 per cent., a difference of over 50 per cent.

This amount of carbonic acid is not enough to appreciably affect the health, which, however, may possibly in some cases be indirectly injured by the fact that windows and doors have to be kept shut to keep out the smoke, and so ventilation is interfered with.

In the case of ordinary chimneys, there is usually no nuisance unless there are windows at a higher level than the chimney-top, into which smoke is carried by the wind. The chimney should then be built higher, or extended, by means of a metallic flue, to a point above the roofs of the adjoining buildings, and the nuisance will be abated. But in the case of factories, the volume of smoke is too great to be thus disposed of, and different appliances have been invented to consume the smoke before it reaches the chimney.

The question has been raised as to the desirability of consuming all the smoke. Consumption means the conversion of this escaping unburned carbon into carbonic acid or carbonic oxide, and the addition of so much of these poisonous gases to the atmosphere. Is not the unburned carbon, it has been said, less noxious and dangerous to the community than the carbon gases would be? As long as we have abundant proof of the discomfort caused by the former, and no evidence at all of any dangerous effects from the latter when discharged into the air from a lofty chimney, the problem seems hardly worth discussing.

One method which has been proposed for preventing the evolution of black smoke is to have the air-draught enter the fire-bed from above instead of from below, and pass through the fresh coal before reaching that already heated. Thus the gaseous emanations and the solid particles from the coal which was becoming ignited would have to pass through the highly heated layer before reaching the chimney. The objection to this is that, the draught being away from the fresh coal instead of toward it, the fire does not burn briskly enough, and the heat contained in the freshly applied coal is not evolved quickly enough to satisfy the present necessities of industrial works. The principle, however, is a good one, and should always be followed in firing any furnace whatever. That is to say, the fresh coal should be put on near the door, so that the unconsumed particles that fly off will have to go over an extensive bed of hot coal before

escaping from the fire-bed. It is too general a practice with stokers to do the exact opposite of this, and throw the fresh fuel toward the back of the furnace, raking the incandescent coal toward the front.

In other cases the smoke from the first fire has been passed through a second one, or over ridges of iron or stone heated to redness. Still other smoke-consumers act on the principle of introducing more oxygen at the rear of the fire-bed, and mingling it with the smoke before it enters the chimney, either by perforations in the bottom and sides of the fire-plate, or by single flues of a larger size. Where this is done, the air should be heated before it is mingled with the gases, or its cooling effect may make the smoke more abundant than before. Others have introduced a jet of steam into the fire; the water is decomposed, and the liberated hydrogen and oxygen, forming new combinations, increase the heat of the fire and diminish the amount of unconsumed carbon.

Some, instead of trying to consume all the carbon, have precipitated it as far as possible in the chimney, either by a jet of steam, or by a spray of cold water. In this way a considerable amount of it may be carried to the bottom or sides of the flue, and removed thence when there is a sufficient accumulation.

Notwithstanding the theoretical perfection of some smoke-consuming apparatus, their success depends so much upon the intelligence and carefulness of the persons who use them, that they are often practically useless. Almost all the forms become clogged with soot and ashes and are very soon inoperative, unless they are frequently examined and cleaned. This the engineers and stokers will not do without constant watching, and consequently smoke-consumers, which work well when first constructed, will often in a very short time have no effect at all, and the nuisance that they were expected to abate will be just as bad as before.

The most successful smoke-consumer that I have seen is one in which the fire-bed is beneath the anterior third of the boiler, and the flame and heated air and smoke are carried thence through a narrow passage between the under side of the boiler for the remainder of its length, and a V-shaped fire-plate with perforations, through which fresh air is sucked in by the draught.

But no smoke-consumer does more than palliate the nuisance and make it less intolerable than before. When the rapidity of the draught, and the impossibility of slowing it much without putting out the fire, are considered, it may be well doubted whether the smoke-nuisance can ever, in the nature of things, be effectively abated, so long as the use of light or porous fuel is adhered to.

5. *Those nuisances which are nuisances on account of the noise caused by them.*

It is quite possible that the difference in the rate of mortality in town and country may be in part due to the constant wear and tear of city life, in comparison with the quiet, humdrum life of country people. And

the nervous strain to which the dwellers in cities are subjected is not alone due to the greater business activity, the more intense rivalry, and the more irregular habits, but also in some degree to the incessant mental concentration required, on account of the many distracting influences that continually assail their senses. Whether the din and rattle of the streets, of machinery, of railroads, etc., actually injure the health of a population, there are no reliable statistics to prove or disprove; but, from the fact that invalids and delicately organized people are distressed by constant noise, it is not an overdrawn inference that the terrible racket which assails the ears of people in our time may be one factor in the remarkable increase of insanity.

Exposure to a bright light, and over-exertion of the eyes in straining to distinguish minute objects, produce, as is well known, certain forms of disease, and result in impaired vision. Why is it not fair to suppose that the incessant pounding of waves of air upon the tympanum, with the violent jarring of the delicate bones and membranes of the ear, may produce changes in that organ which will impair the sense of hearing? It would be interesting to note whether deafness from all causes is more common in cities, and in persons exposed to constant noise, like railroad employees and factory hands, than in those who lead a more quiet life in rural repose.

The most common sources of noise are railroads, factories, machine-shops, forges, boiler-works, steam-whistles, exhaust-pipes, bells, fireworks, and street pavements.

The noise caused by the first five of these nuisances cannot be abated, and such works should always be at a great distance from dwellings.

Steam-whistles are used by many factories as an indication to the employees when to begin and when to stop work. The suddenness of the noise and its piercing quality render it a great nuisance, and in England its employment is regulated by the Steam Whistles Act of 1872. The steam-whistle should be abolished in crowded localities, or at least limited to a single puff of steam, and not be allowed to screech for several minutes, as the custom often is.

Exhaust-pipes should always discharge the spent steam above the roof of the building. Even then the condensed vapor falls in a shower of rain, and constitutes a nuisance to citizens below, and may rust machinery or rot wood in its vicinity. The escaping steam from a high-pressure engine too often makes a peculiar puffing or intermittent blowing sound, which is very distressing to those within hearing of it. Both these objectionable features may be obviated by having the exhaust discharge into a condenser on the roof, which need be nothing more than a covered hogshead, half filled with water, which condenses most of the steam, and muffles the unpleasant sound so that it is scarcely audible.

Church bells and *chimes*, and those attached to factories and schools, together with striking tower-clocks, add to the noise of large towns, and would seem to be entirely unnecessary, though their abolition would probably meet with great opposition.

The nuisance caused by *fireworks* occurs so seldom that it is not so prominent as those previously mentioned. Both on account of the noise and the danger of fire, their use should be limited, and only allowed under strict police regulations.

Among all the noises of a great city, that caused by the rattling of vehicles over streets paved with stone is the worst and the most difficult to prevent. The substitutes for stone pavement which have been most highly recommended for their freedom from noise are wood and asphalt, and of these probably the latter is preferable. The matter of pavements will, however, be discussed elsewhere.

In this chapter many subjects have been omitted, some of them, like coke-ovens, for example, because they do not exist in this country, and others, as the retting of hemp and flax, because, so far as I know, the process is not here attended by nuisance. The aim of the chapter has been not to make a complete résumé of the arts and industries, with the nuisance caused by each, and the method of its abatement, but to mention enough of them, and give enough detail as to processes and results, to furnish medical men with general indications for the management of such nuisances.

BIBLIOGRAPHY.

GENERAL.

D'Arcet: Des rapports de distance qu'il est utile de maintenir entre les fabriques insalubres et les habitations qui les entourent. Annales d'hygiène publique, t. xxx., p. 321. 1848.

Fleury: Cours d'hygiène. Paris, 1852.

Vernois: Traité d'hygiène industrielle et administrative. Paris, 1860.

Tardieu: Dictionnaire d'hygiène publique. Paris, 1862.

Report of the Council of Hygiene and Public Health of the Citizens' Association of New York. New York, 1866.

Pappenheim: Handbuch der Sanitäts-Polizei. Berlin, 1868.

Motard: Traité d'hygiène générale. Paris, 1869.

Freycinet: Traité d'assainissement industriel, etc. Paris, 1870.

Angus Smith: Air and Rain. London, 1872.

Cameron: Manual of Hygiene. London, 1874.

Fonssagrives: Hygiène et assainissement des villes. Paris, 1874.

Letheby: Noxious and Offensive Trades. London, 1875. Reprinted in American Chemist, April, 1875.

Blyth: Dictionary of Hygiene (based on Tardieu's). London, 1876.

Bunel: Établissements insalubres, incommodes et dangereux. Paris, 1876.

Parkes: Manual of Practical Hygiene. London, 1878.

Payen: Industrial Chemistry. Edited by Paul. New York, 1878.

Götel: Oeffentliche Gesundheitspflege in den ausserdeutschen Staaten. Leipzig, 1878.

SPECIAL.

Braconnot et Simonin: Note sur les émanations des fabriques de produits chimiques. Journal de chimie médicale. 1848.

Pellieux: Observations sur les gaz méphitiques des caveaux mortuaires des cimetières de Paris. Ann. d'hygiène publ., Janv., 1849.

Report on Extramural Sepulture. London, 1850.

Becker: Ueber den Einfluss der Leimsiederei, etc. Casper's Vierteljahrschrift, April, 1857.

Bussy: Note sur l'influence des fabriques de produits chimiques sur l'hygiène publique. Journ. de pharm. et de chimie. 1858.

Snow: On Stinking Animal Matters, etc. Lancet, July, 1859.

Angus Smith: Report on Alkali Acts. London, 1865.

Chandler: On Petroleum Oil. New York Board of Health Report. 1870.

Derby: Report on Slaughtering. Mass. State Board of Health Report. 1871.

Perrin: Méphitisme des fosses d'aisance. Ann. d'hygiène publ., July, 1872.

Brunetti: La Cremazione dei Cadaveri. Padova, 1873.

Baker: The Laws relating to Burials. London, 1873.

Smith: Report on Alkali Acts, in Report of Local Government Board. London, 1873-4.

Küchenmeister: Ueber Leichenverbrennung. Erlangen, 1874.

Thompson: Cremation. London, 1874.

Russel: Hydrophobia in Dogs and Other Animals. New York Board of Health Report. 1874-5.

Janes: Offensive Odors from Manufacturing Establishments. New York Board of Health Report. 1874-5.

Goldschmidt: Report on the Gas Nuisance. New York Board of Health Report. 1874-5.

Fleming: Manual of Veterinary Sanitary Science, etc. London, 1875.

Eassie: Cremation of the Dead. London, 1875.

Adams: Cremation and Burial, in Mass. State Board of Health Report. 1875.

Ballard: On Effluvium Nuisances, etc., in Report of Medical Officer of Local Government Board for 1876. London, 1878.

QUARANTINE.

(WITH REFERENCE SOLELY TO SEA-PORT TOWNS.)

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QUARANTINE.

[WITH REFERENCE SOLELY TO SEAPORT TOWNS.]

The principles which should govern the practice and workings of quarantine are certainly among the most complex of hygiene and medicine. If it be borne in mind how varied are the theories that prevail with regard to the conditions of the development of epidemics; the fact that in every country different elements of predisposition or of immunity with regard to these epidemics exists; also that a system of quarantine, while it confers advantages on those it protects, often imposes grave inconveniences on those it interdicts—it will be at once appreciated how difficult it is to express, in administrative formulæ, regulations applicable to every case. The difficulty is still further enhanced by the fact that quarantine, in the first instance, is an offspring of the ignorance, superstition, and a paralyzing fear consequent upon the devastations of some overwhelming scourge of the Middle Ages, which found expression in ill-judged and extreme repression. Even at this day, in many portions of Southern Europe, these ancient traditions still cling with pertinacity to the practical workings of quarantine; indeed, our own country, which of all others should be notably free from any such influence, has in certain places, during the epidemic of the past season, fallen back to the practice and spirit of the Dark Ages, as manifested in the total exclusion of persons and merchandise. In such localities the experience and observation of past epidemics in this and other countries are ignored; the study of the natural history of epidemics, which has faithfully formulated their modes of transmission, and so pointed out the rational measures for their contravention, are lost sight of in the panic which prevails.

Few subjects, therefore, have given rise to opinions so widely diverse, or have been the subject of discussion so varied and extended: on the one hand, the advocates of non-intercourse and exclusion; on the other, the advocates of the most unrestricted intercourse. Until very recently it has been with this last class that the advocates of a rational quarantine were called upon to discuss its legitimate sphere. An unrestricted intercourse followed as a natural result the development of hygienic studies. Regarding filth in all its varied relations as a necessary factor for the presence of disease-germs, the advocates of this doctrine relied upon sani-

tary measures, vigorously applied, as affording the desired protection to any community.

Still a third class should be mentioned in this connection, viz., those who advocate a *uniform* system of quarantine. Those who belong to this class lose sight of the fact that distance from the seat of infection, climatic influences, the peculiar topographical relations of the locality, as well as the social condition of the people, are all so many different elements to be considered in adjusting such a system to a particular place.

Without attempting a historical review of the subject, interesting as it would be, as showing the rise and development of these antagonistic views, it will be the object of this paper to consider the value of the different propositions, point out their respective defects, and illustrate from practical workings principles applicable to any locality.

Definition.—The word "Quarantine," derived in the first instance from the limit of time considered necessary for the observation of persons and merchandise suspected of exposure to pestilential contagion, has in its present application little of its original significance. While the term is no longer intended to express the duration of observation, taken in connection with sanitary studies, it comprises the *whole series of restrictive and sanitary measures* destined to prevent the introduction and spread in a locality of an epidemic or contagious affection. These measures consist not only in placing barriers and restraints to free intercourse, but also in making every effort possible to modify the receptivity of an exposed community, should the seeds of such an epidemic disease be planted in its midst; for the march of every affection transmissible by man is subordinate to two conditions: *first*, the greater or less intensity of the contagion, no matter how transmitted; and *second*, the degree of receptivity of the threatened populations—this susceptibility being dependent chiefly on their hygienic conditions.

All restrictive measures, however applied, have for their object to *stop* the propagation of the morbid cause. Hygienic measures should protect a locality, or it may be section of country, from the action of this cause, either by preventing its penetration or by restricting its development. Now, these two classes of measures, naturally so interdependent the one upon the other, have each been made the exclusive point of departure of sanitarians, both parties regarding the two orders of measures as two distinct, irreconcilable methods. On the one hand, the contagionists, who see in the propagation of an epidemic only a series of morbid acts fatally imposed upon thousands of similar organisms by the contact of a specific germ, advocate only restrictive measures; while on the other hand, the partisans of a spontaneous origin of disease, who ascribe the entire trouble to defective hygienic conditions, overlook the fact that epidemics often invade the most salubrious locality, and therefore must be combated by other measures than those which are purely hygienic. Certainly, hygiene alone cannot confer an immunity comparable to that which keeps the pestilence at a distance, or at least weakens its transmissible properties.

These propositions are far from being purely hypothetical; the teach-

ings of the pure school of hygiene are to-day chiefly accepted in England, where hygienic measures are alone relied on for preventing the ingress of epidemic communicable diseases. The natural result of this doctrine is the suppression of quarantines, the abolition of all obstacles to free commercial intercourse, the unrestricted circulation of passengers and merchandise. The promulgation of such a doctrine would evidently meet a hearty reception among a mercantile and commercial people. Self-interest is a powerful lever to sway and determine definite action, particularly if the teachings of science can be shown to harmonize therewith. As a further consequence of this doctrine, the practical development of hygienic studies has been immensely stimulated in Great Britain, which now occupies the foremost rank among nations in matters pertaining to hygiene. I cannot, however, regard her partial immunity as due wholly to this cause. Her natural isolation from the continental masses; her climatic conditions, which probably render the propagation of the yellow fever germ impossible; her great distance from the endemic seat of the pestilence—all these enable her, so far as yellow fever is concerned, to maintain with impunity the free "*pratique*" of her ports.

While the sameness of language and literature causes us to adopt in so many ways the views and teachings of English scientists, we must not forget that in all the conditions above mentioned we occupy an entirely different situation. Though we concede pre-eminence to her sanitary organization, which extends to every hamlet and locality in the land, we must not blindly adopt conclusions which would cause us to trust to hygienic efforts alone, as a means of repressing the progress of epidemics.

The majority of readers have probably not forgotten how seriously Great Britain, acting on the above principles, suffered from the scourge of the *cattle plague.* The French veterinary surgeons, recognizing early the contagious character of the epidemic, promptly took vigorous measures to strike at the root of the pestilence. In order to prevent the spread of the disease, they found it necessary to kill not more than a hundred cattle; while in England, owing to the anarchy of opinions, events followed their natural course—a mortality of 300,000 cattle was the result.

It is therefore important that clear and positive views should be entertained with regard to the necessity of employing preventive measures before the arrival of a scourge. In harmony with this idea, localities or countries should organize measures which keep at a distance from the mass of the population an approaching pestilence, while at the same time these measures should be of a character that will interfere, as little as possible, with the freedom of individuals and the requirements of commerce. Quarantine and commerce, which for centuries have been antagonistic, can co-operate for the same result. The careful study of the propagation of epidemics shows that repressive action and commercial interests may work in the most perfect harmony; that the series of measures adapted to oppose the introduction of a contagious disease are those which facilitate in the highest degree the active interchange of

commercial products; that, so far from sequestrating commercially localities in which epidemics exist, or obstructing wholly those which may be threatened, an interchange of persons and commodities may constantly occur.

Although the question whether our epidemics of yellow fever are of *indigenous* or *exotic* origin is again being agitated, I do not propose in this connection to review or argue the subject. Yellow fever is not a new visitant to any portion of our sea-board. Epidemics yearly appear upon some part of its vast extent. For nearly two centuries the most careful and painstaking minds of the profession have from time to time studied these incursions, and during that whole period hardly an epidemic has occurred which was not positively traced to importation. While there are instances, in New Orleans and some of the other cities of the Gulf, which would seem to militate against this conclusion, because the disease has appeared in the same locality during consecutive years, this has been satisfactorily explained by the defective sanitary condition of the locality, as also by the fact that the germ had probably remained dormant in some closed building or cellar, where ingress of air had been prevented during the winter months.

From other shores, then, through the channels of commerce, both yellow fever and cholera gain their lodgment. Do not the first dictates of reason respond to the demand that their introduction be prevented, and that measures—call them quarantine or sanitary inspection, it matters not—be taken to prevent their ingress, rather than trust to purely hygienic measures which can at best work only on restricted localities? On the other hand, as we have already intimated, we must not pass to the other extreme of advocating an *obstructive* quarantine. The pestilence of the past season, which has raged so fearfully through the Southwest, has produced a feeling akin to terrorism throughout that whole section. The leading physicians make no other suggestion against future invasions of yellow fever than absolute *non-intercourse* between that section of country and the West Indies for six months of each year. While I recognize fully the difficulties which are inherent to their climate and proximity to the foci of the disease, such recommendations, it appears to me, are not deductions from observation and study, but partake rather of the spirit of the Middle Ages. Nor are these remarks made without weighing their import and future application. An experience of seven seasons, at a port where for four months of each year infected vessels arrive daily, enables me to speak somewhat authoritatively.

Having listened to the detailed recital of the circumstances under which the disease was introduced at New Orleans, I do not hesitate to state, that under similar circumstances yellow fever might be brought to the docks of New York any day during the four months of its prevalence in the harbor. The difficulty at New Orleans was that sanitary observation and inspection existed in name, but not in fact. The people supposed that they were amply protected, but yet the disease showed itself suddenly in their midst. Is it wise under such circumstances, because a system is

imperfectly administered, to condemn it and adopt in its place the extreme doctrine of absolute exclusion? It requires very little experience to show that such a course would in reality be as inoperative and ineffectual as the present system. Commercial activity is so great that no system of exclusion would be tolerated. Rival cities would relax restrictions, especially if founded on no better principles than those which now prevail, and the disease would as certainly be introduced.

A quarantine to be effective must be founded on *principles*, and not merely on the peculiar conditions and requirements of a *locality*. The application of these principles will of course vary with the locality, but the latter should always be a subordinate factor in the problem. Fortunately, in the organization of a quarantine system, our peculiar position—widely separated as we are from the countries of Europe—and our proximity to the "*foyer*" of the yellow fever scourge, have called for independent action, and have enabled us to do away with many of the prejudices which so long clung and still cling to many of the Mediterranean ports. The practices of our system have many of them grown from the very necessities of the position; still others from the careful study of the natural history, modes of propagation, and incubative period of the disease. In each and every place where quarantine is even partially enforced in this country, the intimate relation between the spread of the disease and the failure to isolate those who are sick or suspected, and to enforce absolute cleanliness of vessel as well as of threatened locality, is fully recognized. It is from this standpoint, therefore, that I propose to discuss the question. Any efforts to prevent the propagation of an epidemic must include the full recognition of the necessity for the examination of all suspected vessels at a distance from the centres of population, as well as the most thorough and efficient regulations to secure the best hygienic conditions of the threatened community. Here too, before entering upon the discussion of the measures best adapted to promote this purpose, I must recognize the efficiency and utility of a principle as applicable in the larger field of national hygiene as in the local and municipal one.

Physicians—and now, even in advance of physicians, the general public—recognize as of greater importance the *prevention* of local maladies, rather than the most skilful treatment of those diseases when actually in our midst. So, too, in the broader field of national hygiene, the importance of jugulating epidemics at their *place of origin* is a far higher and more important duty than the execution of the most studied measures of exclusion when the disease is actually upon us.

The want of some common, international code of principles prevents that unity of action so desirable in all such matters. Still, in Europe very much has already been done to impede the propagation and spread of cholera. Though the *endémicité* of this scourge is upon the banks of the Ganges, where the teeming population and peculiar habits of the people render local action impracticable, still there is a field where preventive measures can be utilized before the disease reaches the confines of Europe. Observation has shown that the epidemics which have from time to time

during this century devastated such large areas have been usually brought overland by the caravans—those, on the one hand, which pass for commercial purposes into Russia, and chiefly, on the other, the hundreds of thousands of Mahomedans who make their annual religious pilgrimage to Mecca. Vast bodies of pilgrims from the shores of the Mediterranean also congregated at the same place, and, upon their return, introduced the disease into all parts of Egypt, Turkey, and the Levant. The germs were scattered among filthy and receptive populations, and thus the disease spread until it assumed the proportions of a scourge. France, fully awake to this source of danger, has, by her influence and arguments in the different international medical congresses, succeeded in having sanitary officers placed not only at Mecca and Medina, but at all the principal seaports of the Red Sea and the Mediterranean, where the return embarkation of the pilgrims occurs. It is the duty of these officers to inspect carefully and constantly the sanitary condition of the pilgrims ; to telegraph the first outbreak to the medical officers on the coast, who in their turn send word to the central authorities of Turkey and Egypt. It is also their duty to prevent the departure of the pilgrims until all traces of the disease have disappeared, and so stamp it out at its second *endémicité*. Every year, for the past six years during which this system has been in operation, cholera has appeared among the pilgrims, and has been jugulated before it gained a foothold on the shores of Europe.

Thanks to the thinly settled frontier of Russia, the approach to which is limited to certain routes and passes, the military *cordon sanitaire*—which is only applicable under such conditions—has effectually arrested the progress of cholera in that direction. May we not hope, with the fuller and more perfect development of these *true preventive* measures, that the world will be spared further desolation from this scourge.

Turning to our own country, we stand in almost similar relations with regard to the incursions of yellow fever. It is conceded by the vast majority of observers of the disease, that it is nowhere endemic upon the coast of the United States. If this be so, the principles applied to the prevention of the transmission of cholera can be equally applied to the prevention of yellow fever. Its chief habitats, so far as danger to this country is concerned, are Havana and Vera Cruz, although the city of Rio Janeiro seems similarly related. The situation of the latter port, however—in the southern hemisphere, where the seasons are the reverse of those in the northern—the prevalence of the disease there during our cold weather, and the length of the voyage, make its propagation from that source almost impossible. It is chiefly at Havana, then, that the principles referred to should be applied. In view of its proximity to the whole of our southern coast, and in view of the fact that the time of transit from there to any of our numerous ports is within the period of incubation, it seems to be very desirable that some decided measures should be taken by the Spanish Government to destroy the constant receptivity of Havana to this disease.

While I cannot speak from personal knowledge, conversations with resi-

dents and with those whose communication by vessels is constant, convince me that a thorough system of sanitary measures applied to the city and surroundings would go far toward attaining this desired end. It is not within the province of this paper to discuss the measures by which such a result could be effected; but, in view of the enormous commercial interests common to the two countries, it would seem of great importance that our government should take some decided action looking to that result.

Thanks to improved facilities of transportation, ship fever has within fifteen years become almost a mythical disease. If cholera can be stamped out at its place of inception, it will cease to be the terror of nations; and so, if yellow fever can be robbed of its virulence, we shall have done more to solve the teasing and difficult problem of contravention of persons and merchandise than have the most enlightened efforts of local sanitarians; for the efforts of all true students in this direction must be to contravene as little as possible the rights of the few, while seeking the welfare of the many.

Quarantine regulations in most of the ports of this country recognize four diseases subject to control, viz., small-pox, ship fever, yellow fever, and cholera. Since each of these diseases has special and peculiar modes of propagation, so to each special restrictive measures must be applied. Before, however, the scope of these measures, with relation to the disease to be excluded, can be considered, certain general rules pertaining to the organization of quarantine establishments, the inspection of vessels on their arrival at the port of entry, the health of the ports of departure, and the modes of obtaining necessary information concerning the sanitary condition not only of these ports, but also of the vessel during transit, must be laid down.

The prevention by quarantine measures of the introduction of any communicable disease into a community presupposes the organization of an establishment, where not only a thorough inspection of all incoming vessels can be made, but also where full provision can be afforded for the sequestration of those suspected. Hospital facilities, then, are required for ship fever, small-pox, yellow fever, and cholera; for it is not impossible, and indeed, it has frequently occurred in the history of New York quarantine, that two or more of these diseases have, at the same time, been under the supervision of the medical officer. It is manifestly improper and inhuman to subject a person recovering from one disease to the contagious influence of another. The hospitals, therefore, where those actually ill are lodged, must not only be separated at certain distances the one from the other, but the quarters allotted to those who are merely suspected and kept under observation should also be separate and distant from the hospitals.

In addition to the above there should also be a boarding station, removed both from the hospitals and from the quarters of those who are kept under observation, from which to proceed to inspect incoming vessels. To have the boarding station in proximity to the hospitals would unnecessarily expose those arriving in healthy ships.

We have, then, in the organization of a quarantine :

First.—The *boarding station*, consisting of suitable wharves, boats for boarding steamboats and for the transportation of sick, and residences for the medical officers.

Second.—The *place of sequestration* for those who are well, but who have been exposed to one or the other of the above diseases, and have not yet passed beyond the period of incubation.

Third.—The hospitals, placed at distances apart sufficiently great to prevent the germs of one disease being transmitted to the other buildings, and provided each with the necessary complement of nurses and attendants.

At the New York quarantine no special hospitals exist for ship fever or small-pox. Cases of the former disease when arriving are sent to the State Emigrant Hospitals, at Ward's Island, where the desired isolation can easily be effected ; cases of the latter disease are sent to the Riverside (small-pox) Hospital, on Blackwell's Island. Hospital provision, however, is made both for yellow fever and for cholera.

The construction of hospitals for the reception of yellow fever and cholera patients should be of the simplest character, for, should they become contaminated with the infection of either disease, nothing but absolute destruction of the buildings could induce a feeling of safety. In the latitudes where, and at the seasons of the year when, yellow fever prevails, it is seldom that any artificial heat will be required, so that simple wooden pavilions or good wall-tents will suffice. If, however, the buildings are to be permanent, provision must be made for administrative apartments, drainage, sewerage, heating, cooking, and the fumigation and disinfection of clothing and effects. Those in New York harbor are in all the above requirements thoroughly equipped. The buildings for the detention of well persons during the period of observation should be of a permanent character, with appliances for their well-being and comfort during the period of sequestration.

Without an exception, so far as I can recall, every seaport on the coast of the United States has admirable facilities for the proper location of quarantine structures. There are on the sea-approaches either suitable islands, isolated land-spits, or reefs sufficiently far removed from the population to dispel the idea of danger from proximity or necessary intercourse.

It is almost needless to suggest that in the selection of a site, care should be taken to avoid as far as may be the action of malaria, so that its poison may not be superadded to that of the epidemic.

With this brief recital of the requirements of a quarantine station, I pass next to the relations of the vessel itself.

In order that a community shall be thoroughly protected from epidemic influence, sanitary inspection should be made of every vessel entering the port, and at all seasons of the year. In the case of healthy vessels from healthy ports, very little delay is occasioned, while any additional expense is more than counterbalanced by the feeling of security conferred upon a

community. To wait until disease arrives, or, as would more probably happen, until it has made a lodgement, would but be an effort to check a misfortune after its influences had matured. Certainly, in sanitary matters, prevention and foresight are even more important than in ordinary matters of daily life. Applied to quarantine administration, it simply embodies the principle which underlies that great and ever increasing movement, now going on among all civilized people, called "preventive medicine."

Every vessel then, on her arrival at the boarding station, should be promptly visited. The points for examination are as follows:

First.—Establish the sanitary condition of the "port of departure."

Second.—Establish the sanitary condition of the vessel at the time of leaving.

Third.—Ascertain her history during the passage.

Fourth.—Investigate her sanitary condition on arrival with reference to cleanliness of the quarters of passengers and crew, character and variety of provisions, drinking water, etc.

To determine the first it is necessary to examine the bill of health, given at the port of departure, either by the governmental authorities or by the U. S. Consul at that place. The form adopted by this government, of which the subjoined is a copy, is, I think, very imperfect. Even the little information it is supposed to convey has in the majority of cases proved unreliable, because the consuls fail to state the true condition of health on shore or among the shipping. Until an epidemic condition is notorious, they rarely make mention of sickness. I consider this attributable, in part, to the very general form of information called for.

Form No. 36. Appendix. V. Con. Reg. 1874.

BILL OF HEALTH - - CLEAN.

I, ... *Consul of the United States at*

PORT ANTONIO, JAMAICA, *do hereby certify that* .... *called the*

.... *of* .... *burthen per register* .... *tons, commanded by*

.... *navigated by* .... *men, and having on board*

.... *passengers, leaves the port of Port Antonio, Jamaica, in free*

pratique, (or in quarantine,) bound for .... *U. S. A.*

I CERTIFY, *That good health is enjoyed in this town and the adjacent country, without any suspicion of plague, cholera, or contagious distemper whatever.*

IN WITNESS WHEREOF, *We have hereunto set our hand and seal of office, at Port Antonio, Jamaica, this* .... *day of* 187

[SEAL.]

....

U. S. CONSULAR AGENT.

The bill of health should contain specific blanks for cholera, small-pox, and yellow fever, in which should be filled the weekly or daily number of cases occurring, as also the sanitary history of the vessel while in port, and her condition as to sickness, cleanliness, and character of food at the time of leaving. Such a sanitary supervision could in no way be irksome or exacting of the shipmaster, and would call his attention to, as well as require his supervision of, such sanitary points as are, in the great majority of cases, overlooked.

The form of bill of health adopted by the French Government, a copy of which is herewith annexed (p. 483), contrasts in this respect most favorably against our own.

For information regarding the passengers and crew in transit, in addition to the statement of the captain and surgeon (should there be one on board), an examination of the log-book should be made. By universal regulation of commercial nations, this book must be a daily, almost hourly record of every event which has occurred on board; any omission from, or perversion of which, is punishable. It is therefore a very reliable and exact transcript of the voyage.

It is next essential to determine the sanitary condition of the vessel, passengers, etc., on arrival. Inspection is made by the boarding officer of the cleanliness of the quarters of the crew and steerage passengers. Every part of the steerage should be examined, and if negligence or indifference in regard to these places is apparent, the vessel should be detained until a thorough cleaning is effected. Time is so important a factor to steamers, that the detention of the vessel for a few hours, for purposes of purification, rarely renders a second correction for the same vessel necessary.

It is also made the interest of masters and owners to look after the sanitary condition of the passengers when first going on board. On vessels coming from infected ports, the captain is taught that, in caring for the sanitary condition of the crew and vessel while in port, he will be much less likely to contract disease, or have the vessel become infected. Indeed, the captain's part is not a passive one, either in the prevention of epidemic disease, or in its suppression when once it has appeared. Cleanliness of the vessel in an infected port can be aided by pumping in fresh water daily into the bilge, and then pumping out again. A frequent change of water goes far to prevent a lodgment of the germs. Sailors, after the completion of the day's work, should be required to take a bath and to put on clean flannels, and they should not be allowed to sleep in the open air. Shipmasters who have for years sailed to yellow fever ports have told me that, by rigidly following the above requirements, they have never had a case.

After inspection of the quarters, as above suggested, the steerage passengers should be assembled upon the deck, and pass one by one before the inspecting officer. It might at first be supposed that the bill of health, the log-book, and the sworn statement of the captain and surgeon, would sufficiently establish the sanitary condition of the steerage passengers. Experience, however, has shown the necessity for personal inspec-

No. RÉPUBLIQUE FRANÇAISE. *Port*

ADMINISTRATION SANITAIRE.

PATENTE DE SANTÉ.

Nous, de la santé à , certifions que le Bâtiment ci-après désigné part de ce port dans les conditions suivantes, dûment constatées:

Nom du bâtiment............	*Etat hygiénique du navire*.......
Nature du bâtiment........	
Pavillon....................	
Tonneaux..................	*Etat hygiénique de l'équipage (couchage, vêtements, etc.)* ....
Canons.....................	
Appartenant au port d........	
Destination..................	*Etat hygiénique des passagers*....
Nom du capitaine............	
Nom du médecin............	*Vivres et approvisionnem[ts] divers.*
Equipage (tout compris).......	
Passagers....................	
Cargaison..................	*Eau*.... ....

Malades à bord.

Nous certifions, en outre, que l'état sanitaire du pays et de ses environs est

et qu'on constate cas de............. { *choléra indien* / *fièvre jaune* / *peste* }

En foi de quoi nous avons délivré la présente Patente à , le du mois d , 187 , à heure du

L'Expéditionnaire de la Patente, *de l'Administration,* — *Sceau* [SEAL.] — Le de la santé,

PRESCRIPTIONS EXTRAITES DU RÈGLEMENT GÉNÉRAL DE POLICE SANITAIRE MARITIME.

1° Tout navire qui arrive dans un port français doit, avant toute communication, être reconnu par l'autorité sanitaire. (*Art. 4 du règlement.*)

2° La présentation d'une patente de santé, à l'arrivée dans un port de France, est obligatoire *en tout temps* pour les navires provenant des côtes orientales de la Turquie d'Europe, du littoral de la mer Noire et de tous les pays situés hors de l'Europe, l'Algérie exceptée. (*Art. 8 du règlement.*)

3° Pour les provenances autres que celles mentionnées précédemment, la patente de santé n'est obligatoire qu'*en temps d'épidémie* régnant dans le pays ou le voisinage du pays d'où provient le navire. (*Art. 9 et 10 du règlement.*)

4° *A l'étranger*, pour les navires français à destination de France, la patente de santé est délivrée par le consul français du port de départ ou, à défaut de consul, par l'autorité locale.

Pour les navires étrangers à destination de France, la patente peut être délivrée par l'autorité locale; mais, dans ce cas, elle doit être visée, *dans sa teneur*, par le consul français. (*Art. 14 du règlement.*)

5° La patente de santé délivrée au port de départ doit être visée à chaque escale que fait le navire et conservée jusqu'au port de destination définitive. Il est du devoir du capitaine de ne pas s'en dessaisir; à cet effet, si le navire fait escale, le consul français du port de relâche doit seulement apposer sur la patente délivrée au point de départ un *visa* relatant l'état sanitaire de sa résidence; mais ni le consul ni l'autorité locale n'ont le droit de retenir cette patente ni de la remplacer par une autre. (*Art. 15 du règlement.*)

6° Un navire ne doit avoir qu'une seule patente de santé. (*Art. 17 du règlement.*)

7° La patente de santé n'est valable que si elle a été délivrée dans les quarante-huit heures qui ont précédé le départ du navire. (*Art. 18 du règlement.*)

8° Le capitaine d'un navire dépourvu de patente de santé, alors qu'à raison de sa provenance il devrait en être muni, ou ayant une patente irrégulière, tombe, à son arrivée dans un port français, sous le coup de l'article 14 de la loi du 3 mars 1822, sans préjudice de la quarantaine à laquelle le navire peut être assujetti par le fait de sa provenance, ni des poursuites qui pourraient être exercées en cas de fraude. (*Art. 19 du règlement.*)

9° Pour les navires qui n'ont pas de médecin, les renseignements relatifs à l'état sanitaire et aux communications en mer sont recueillis par le capitaine et inscrits sur son livre de bord. (*Art. 25 du règlement.*)

tion. Nearly half the cases of small-pox (in the form of varioloid) detected at this port are first noticed by this passing of the steerage passengers before the doctor. There is often a disposition on the part of the sick on shipboard to conceal their malady, if not severe, from the fear of being separated from friends, so that the detection of the disease by the boarding officer is often the first intimation that the officers of the vessel have of its existence.

If the bill of health, the log-book, and personal examination are satisfactory as to the condition of every person and thing on board, "*pratique*" is given, and the vessel proceeds at once to the wharves. On the opposite page will be found the form of pratique given at the port of New York.

If, on the other hand, the bill of health is unsatisfactory, those measures must be taken which will be detailed when speaking of the interdictions peculiar to each form of sickness.

Perhaps at no part of this paper can I better consider the relations which steamers and sailing-vessels maintain to each other in disseminating the germs of epidemics. For if, upon examination, it be found that the conditions prevailing upon steamers and sailing-vessels are different—that, for example, the facilities for transmission of cholera are increased in proportion to the rapidity of transportation and the greater number of individuals carried, and that in the case of steamers the receptivity of the vessel to yellow fever germs is modified, it follows that the quarantine regulations which should govern them respectively should also be adapted to their peculiar facilities for retarding the development of the germ in the one disease, and for facilitating its transmission in the other.

First, steamers are far less liable than sailing-vessels to become infected with the germs of yellow fever. It is admitted by most writers that yellow fever is not contagious, or, if under certain conditions it becomes so, it is so slight as not to require consideration in this connection. It is then transmitted from place to place by the vessel, the cargo, the baggage and effects of passengers and sailors. The conditions which would modify this receptivity in the two classes of vessels should therefore be taken into account. Of the ways of transmission, the vessel itself plays the most important part. The germs of yellow fever increase with fearful rapidity where the conditions of filth, heat, and fermentation are in active operation. These are supplied in full measure in the hold of a vessel lying for weeks under a tropical sun, being loaded, as most of those coming from fever ports are, with crude sugar and melado. It is in the bilge of the vessel where this filth accumulates, and where the fever-germ revels in its propagation. The facilities for removing this filth and maintaining cleanliness are far greater on steamers than on sailing-vessels. In the former, in addition to the filth from the cargo, the oil and dirt from the machinery, the water from condensed steam, settle in the bilge, to remove which the steam-pump is brought into frequent use. Not only can the matters which accumulate there be readily pumped out, but clean water may from time to time be thrown in to remove more effectually the filth, and preserve the vessel from disagreeable odors. On the

(*Front*).

PORT OF NEW YORK, 187

Tons,

Arrived,

Commander,

Date of sailing,

From

Officers and crew,

Passengers: { First Cabin, Second Cabin, Steerage, }

Cargo,

Consignee { Vessel, Cargo,

Health,

PORT OF NEW YORY.

—o—

QUARANTINE, 187

Arrived,

Commander,

Days Passage,

From

Crew,

Passengers,

Cargo,

This Vessel has permission to proceed.

Health Officer.

—o—

☞This PERMIT to be exhibited at the OFFICE OF THE BOARD OF HEALTH within twenty-four hours (Sundays excepted) of your arrival at Dock, under the penalty of TWO HUNDRED DOLLARS.

[See the other side.]

(*Reverse*).

THE CAPTAIN OR PERSON

HAVING CHARGE OF THE VESSEL named in this Permit is hereby notified to LAND ALL EMIGRANT PASSENGERS and their personal baggage on board this vessel, at the Dock or Pier adjoining Castle Garden on the west, and being part of Castle Garden, in the City of New York.

A failure to comply with this notice will subject the Master and owners to a PENALTY OF FIFTY DOLLARS for each passenger or his or her personal baggage, landed at any other place. The law also prohibits (prior to the landing of the passengers), any Emigrant Runners, or other persons on behalf of any Steamboat, Railroad, or other forwarding line or Company, or Emigrant Boarding-House, from coming on board.

A violation of this law subjects the Master and Owners to a PENALTY OF FIVE HUNDRED DOLLARS, and any person except the MASTER, OWNER OR CONSIGNEE, who shall go on board the vessel before this Permit shall be delivered, shall be guilty of a misdemeanor, punishable by fine and imprisonment.

Any person, also, who shall neglect or refuse to comply with any provision of the law relative to Quarantine, or with any direction or regulation which the Health Officer may prescribe in the execution of the powers imposed and conferred upon him by law, shall be guilty of the like offence, and subject to the like punishment.

QUARANTINE, 187

The undersigned, Captain and Surgeon, of the

from each being duly sworn, deposes and says: that the Port or Ports from which he sailed were to the best of his knowledge and belief, perfectly healthy, being free from all malignant, contagious and infectious disease, that no such disease existed among the shipping in said Port or Ports at the time of his departure, and that no case of sickness or death from Small Pox, Cholera, Yellow Fever, Ship Fever, or any other contagious or infectious disease has occurred on board of his vessel, while in any port or on the passage.

SWORN BEFORE ME THIS DAY OF }

HEALTH OFFICER.

other hand, in sailing-vessels all pumping must be done by hand, and is just so much less effectual and imperfectly performed; consequently, in the same proportion is the vessel liable to convey the morbid germs.

Again, steamers, in most instances, belong to lines which run at regular intervals, remaining in port but a few days, as the cargo is already engaged by regular consignees. Sailing-vessels, on the other hand, often lie for weeks in an infected port, under a tropical sun, and their officers are too often indifferent to the hygienic conditions of the vessel and crew, until the vessel becomes a pest-house of sickness; or, if the occupants escape while still in port, the germs remain in the bilge, and yellow fever breaks out later—the length of the voyage, a fermentable cargo, a dark and heated hold, all favoring the development of the disease.

As just intimated, the length of time occupied by the voyage is a decided element in favor of steamers, in lessening the opportunity for the development of the germ; for, as I shall show when speaking of the measures proper to repress yellow fever, I regard it of the highest moment that vessels should be discharged as soon as they enter port. Steamers also possess the appliances for forced ventilation, and currents of air may thus be kept circulating throughout the vessel, a condition unfavorable for germ-propagation. Experience of some years has, I think, shown that steamers rarely become "infected." While not unfrequently they reach this port with sick persons, it will usually be found that these individuals came on board during the incubative period of the disease, having contracted it while on land.

The average duration of the trip of a sailing-vessel extends in most cases far beyond the period of incubation, and the cases of sickness she brings to port must be regarded as deriving their origin from the vessel.

While as a precautionary measure both must discharge in quarantine, the deduction is a fair one that far less danger of importing the disease is to be ascribed to the steamer than to the sailing-vessel, and that measures of cleanliness and disinfection should be more thoroughly carried out on the latter. It may also be added that the facilities of cleaning with steam-pumps, after discharge of the cargo, are manifestly also in favor of the steamer. It is also a proper question to consider whether an iron vessel would be as likely to become infected as one of wood, where the saturation of the latter would be another element in the fermentative or decomposing process.

While, then, I regard steamers as exerting a favorable sanitary influence in the prevention of the transmission of yellow fever, as compared with sailing-vessels, their relation to the transmission of cholera is the reverse. This latter disease is transmitted primarily by the individual, and not, as in yellow fever, wholly by the surroundings. Whatever, therefore, favors the rapid intercommunication of people, favors to just that extent the dissemination of the propagating element of cholera. Since the introduction of sea-going steamers, cholera has appeared almost simultaneously in the different portions of Europe. So long as its presence is limited to the caravans on the steppes, or to the thronging crowds of pil-

grims at Mecca, little danger exists of its rapid dissemination. When, however, these pilgrims crowd the sea-shore, every steamer—it may be every pilgrim—is a focus for its dissemination along the shores of the Mediterranean. Fortunately, however, for this country, the very means which favor the spread of the disease can also be used for its repression. The principle which some of the governments of Europe are so happily bringing into practical application, that of jugulating it in its place of inception on land, can equally be employed on steamers.

The common sailor is so much a fatalist, so accustomed to passive submission to the will of his superiors, that when sickness occurs he looks around but little for means of repression ; and the officers are not much better informed of their ability in this particular. There is, however, in the organization of a steamer a perfect miniature of a community on shore, with active agencies and appliances. Officers on such vessels should be made to realize that duty is not limited to the cure of those who are at the moment sick, but that active preventive measures are within their reach. The disease is propagated by the individual ; therefore isolate promptly the suspected and sick ; disinfect the discharges while they are still inert (for, fortunately, we know that the choleraic discharge is characterized by a period of inertness) ; maintain absolute cleanliness in person and clothing, not only of the sick, but also of the attendants, and the disease may be stamped out before the steamer reaches her destined port. Reaching the port, it becomes then the problem of sanitary officers to limit its presence to the isolated community which has been the vehicle of transmission.

It remains now for us to consider separately each of the diseases subject to quarantine, with a view to determining the repressive measures proper with regard to each. The adaptation of these measures to the requirements of every emergency and every locality rests upon a simple principle, viz., to keep clearly before the mind *the modes of transmission*, together with the *incubative period* of each form of epidemic—in a word, to be thoroughly familiar with the natural history of the disease. Studied from this standpoint, quarantine requires no arbitrary rules or formulæ. The repressive measures for each malady must be founded upon its own manifestations ; and so, too, the proper course to pursue in the case of each vessel must be decided by the particular features of its exposure. From this standpoint too we obtain what is so much talked about, but so little understood, viz., a "uniform system" of quarantine, the principle being uniform, varied though it may be by latitude and particular features of locality.

In this country the scourge against which we are most commonly called to contend is yellow fever, since it has become a yearly visitant to some part of our extensive seaboard. Nor is this strange. The commercial relations which exist between all the Atlantic and Gulf ports—particularly that of New York and the places of its *endémicité* in the West Indies, are so constant and extensive, that its transmission to one or the other of these ports is an event of almost daily occurrence. From the

first or middle of June until the middle of October, yellow fever is rarely absent from the hospital in this harbor.

Conveyed, as it is, chiefly in sailing-vessels, the crews of which usually number from eight to ten men each, the disease is rarely represented in hospital at any one time by more than two or three patients. During the past summer, a period of three days did not elapse without the presence of the disease. Despite this condition, no delays or impediments were imposed on commerce, and vessels bringing sickness, as well as those from infected ports, were in most instances returned to commerce sooner than if they had proceeded at once to the city, with free *pratique*, and had discharged their cargoes with the delays incident to dockage, stevedores, etc.

The practical measures adopted are, as already stated, founded upon the period of incubation and the modes of transmission of the disease. The practical limit fixed for the former is five days. Many cases appear in a shorter time than this after exposure, while it is very rare that the incubative stage can be definitely fixed as of longer duration. Let me first consider what measures are proper to be taken with reference to passengers.

A vessel leaving an infected port requires a variable time of from two five days to reach one of our many seaports. The period of incubation of the disease is allowed to date from the time of departure of the vessel from the infected port. It may safely be assumed that the passengers are apparently well when they come on board, for if the fever has seized them they are usually too ill to move about; or, if they are slightly ill, the masters of vessels will, for their own protection, forbid their coming on board.

On the arrival of the vessel at quarantine, examination is made of each passenger, their baggage opened, placed in a closed room, and thoroughly fumigated. If at the expiration of five days after leaving an infected port no case of sickness has occurred, *pratique* is given the passengers and baggage, and they are sent on a steamboat to the city. Although thousands of passengers have arrived from infected ports at the port of New York during the past seven years, no case of fever has ever appeared after *pratique* has been given.

If, however, a case of fever has occurred during the passage, it does not of necessity preclude the discharge of the remainder at the expiration of five days. A careful enquiry is instituted with reference to the previous history of the individual—the length of time which elapsed after coming on board before he was taken sick, to determine whether the disease was contracted before or after this period. If, as is ordinarily the case, it dates previous to his coming on the vessel, the remaining passengers are not detained beyond the five days. Another circumstance in this connection should be noted. During the summer months the great proportion of passengers arriving are acclimated or native Cubans. From these no danger is to be apprehended, which lessens to just that extent the number of those requiring a rigid examination.

If, on the other hand, it appears probable that the disease was con-

tracted on the vessel, the passengers should be removed to the quarantine for observation; baggage of all kinds should be thoroughly aired and disinfected; if there be any soiled articles, they must be washed before they are removed from the vessel; and if, at the expiration of five days from the appearance of the last case, no new cases of sickness occur, the passengers may be discharged. All this work, as indeed everything connected with the discharge and purification of vessels, passengers, etc., in quarantine, should be carried on some distance from the main shore, either on islands or on hulks of vessels prepared for the purpose. The experience of the epidemic of yellow fever at St. Nazaire, France, showed clearly that the germs of the disease are wafted but limited distances by the air, and that whenever the epidemic has reached the main-land from vessels lying at some distance, it has been from infected articles which have floated to the beach, rather than by air-currents.

Should it be necessary to perform the operations just alluded to on the main-land, no certain immunity can be assured to the neighboring populations. The filth which accumulates about docks, and the almost invariable proximity of low and marshy soils, afford a nidus from which the germs will most certainly, under favorable influences of temperature, spread to the centres of population.

The next care is for the *vessel.* As has been stated, I consider the danger from the receptivity to the poison to be far less on steamers than on sailing-vessels; still the necessity of protection to the community, and the little additional expense attending the measures adopted, have induced me thus far to treat both classes alike, so far, at least, as relates to discharging in quarantine. Steamers, however, are allowed to commence this discharge as soon as passengers have left, while sailing-vessels must undergo a preliminary purification.

Steamers, before proceeding to the lighterage ground to discharge, are fumigated at least twice in every attainable part of the vessel. I have, however, during the past season, made a further exception in the case of steamers having mixed cargoes from non-infected and infected ports, the cargo from non-infected ports having been taken on first. Feeling assured that no germs could exist in the bilge—their favorite nidus on sailing-vessels—because it is of necessity cleansed once or twice in twenty-four hours, by first pumping in clean water and then pumping the whole out again, I have discharged in quarantine that portion of the cargo which came from infected ports, and allowed the remainder to go to the dock in the city. Here too the nature of the cargo would influence my action. In the cases alluded to it consisted either of new hard-baled hemp or tobacco, neither of which, unless under peculiar circumstances, would be vehicles for transmission.

Sailing-vessels on their arrival remain from twenty-four to forty-eight hours at the boarding station, according to the cleanliness of the vessel and her record during the voyage. This time is occupied as follows: the hatches are opened and everything possible is done to allow the largest ventilation. The cabins, quarters of the men, and every part which

can be reached, are thoroughly scrubbed, fumigated, and disinfected. All clothing and dunnage are washed and hung out to dry. When this has been satisfactorily performed, the vessel is immediately sent to the discharging ground. No time is wasted for a specific detention at quarantine. If the vessel is infected, the sooner the discharge is completed, the less probability is there of its gaining in intensity, and the sooner can the hold be reached to clean and disinfect. I never could understand the object of a detention for a period longer than is necessary to effect the cleanliness and aëration of such parts of the vessel as could be readily reached. That completed, remove at once the cargo, so that the cleansing and disinfection can be carried to all parts.

All that we know of the yellow fever germ teaches us that it propagates with the greatest rapidity whenever the elements of heat, moisture, fermentation, and no circulation of air are present. These elements are eminently combined in vessels coming from the tropics. Their cargo is sugar or melado; they are put on board under a tropical sun; both are dirty cargoes, and more or less leakage goes on into the bilge; the hatches, too, are tightly battened. If the germs are on the vessel, can there be conditions more favorable than these for their active increase? Experience daily teaches us that on such vessels, should the voyage be prolonged, cases of sickness follow each other in rapid succession until the vessel becomes a very pest-house; whereas, if the voyage is completed in eight or ten days, we find the sickness breaking out but a day or two before entering port, where prompt measures put a stop to its further progress. The longer such a vessel is allowed to remain untouched, *i. e.*, the longer a quarantine is exacted, the greater will be the virulence of the disease, and the greater the danger of spreading the infection. The epidemic which appeared at Bay Ridge, Long Island, some years since, was undoubtedly due to this cause. Vessels were strung along the Long Island shore to ride out a specific quarantine, until the whole fleet was thoroughly infected, and the disease passed readily to the main-land. It is this practice of detention which in the past has contravened the interests of shipping and commercial men and has kept up a chronic warfare between merchants and quarantine. The material injury which results from detaining cargoes and vessels so long from active circulation has done irreparable injury to many a shipping port. It is, therefore, a matter of congratulation that the action which recognizes the protection of the public health also favors the activity of shipping and commercial enterprises. Simple and self-evident as this course appears, when we reason in the abstract, the greatest difficulty is often experienced in putting it into actual operation. The panic and fear prevalent on the approach of an epidemic are too apt to override all careful deductions, and restrictive and repressive measures are adopted which in reality add to the threatened danger. It would seem that the action taken at this port with such happy results should encourage decision in others.

The discharge of the vessel should then go on at the earliest moment after the preliminary purification. The manner in which this is to be per-

formed I regard as the most important step in the prevention and obstruction of the spread of the germs of yellow fever to the centres of population. The experience of many years at this port—and in this I am confirmed by the observations of the St. Nazaire epidemic in 1862, and others in Spain and Portugal—has led to the conclusion that little danger of transmission arises from the cargo proper. The clothing and effects of the individual, and the dark recesses of the hold, are the favorite lurking-places of the poison.

In the case of the city of New York, the vessel is sent to the upper bay for the purpose of discharging the cargo, the spot being nearly two miles distant from the nearest shore, where the bay is five or six miles wide. The crew of the vessel is usually discharged before the cargo is broken. Stevedores, coopers, and all who work in the hold at this discharge, reside in hulks anchored near by, and are not allowed to return to the city until a period of five days has elapsed since they worked on a suspected vessel. The cargo is swung upon open lighters and then carried to storehouses about three miles distant. No special precaution is exacted by the lightermen, except that they are not allowed to go on the vessel which is being unladen; nor is the cargo subjected to any restrictions concerning the warehousing. During the discharge of the cargo, fumigations with chlorine should be made once or twice daily.

The vessel once emptied of her cargo, the process of purification begins. With steamers this is comparatively speedy and easy of accom-accomplishment. A fire-hose is attached to the force-pump, carried to the hold, and a full head of water thrown into every part of it; at the same time men are set to work with scrub-brooms, who work until every portion has been scrubbed and is as clean as a housewife's kitchen. A discharge-pump is kept working at the same time, and the water is poured in, not only until thorough scrubbing is completed, but until the discharge-water is as clean as that which enters. Hatches are left off, ports are opened, and the fullest airing is given until the vessel is dry; then everything is closed, and fumigation is started in every part of the vessel.

Pratique is then given, and the vessel returns to commerce.

With sailing-vessels the process of purification is slower, on account of the absence of the steam-pump. It is often found advisable to have a tug-boat lie alongside, so that use may be made of its force-pump and hose in the same manner as on a steamer. The subsequent measures to be carried out are the same in both kinds of vessels. In other cases dependence must be placed upon the ordinary hand deck-pump; the purification and cleansing, though occupying a longer time, can be made equally effective. I place far more reliance upon the liberal use of water, the scrubbing until the vessel is absolutely clean, the pouring out of clean water from the bilge, than upon any process of mere disinfection and fumigation.

These measures, which are simple and easy of application, are, I believe, when thoroughly carried out, perfectly efficient; yet there seems to be a disposition among some to substitute for them more complicated methods, in the belief that the yellow fever germ possesses a peculiar

tenacity of life, and that consequently peculiar and mysterious agencies must be used to eradicate it. On the one hand are numberless patent compounds, said to contain some marvellous admixture the very presence of which in the hold of a vessel will destroy the vitality of germs. These compounds must be applied by aid of some patent machine, which is also essential to their efficacy. In my judgment all such preparations and machines are worse than useless; for, not only are they inefficacious for the purpose intended, but they beget a false confidence, which causes the neglect of that most important of all disinfectants, absolute cleanliness. Disinfectants, fumigations, and all that class of measures, should be regarded merely as adjuvants, useful for the purpose of reaching portions of the vessel which in the process of cleaning may possibly have been overlooked, or where the cleansing could not have been absolutely thorough. I am not aware that chemistry presents any two articles more readily applied, more rapid of generation, or possessed of greater oxidizing and permeating properties, than sulphurous acid gas and chlorine.

While all such work must be thorough, we should not lose sight of the economical feature in the process. A method of purification, which may be unobjectionablé in principle, may also be so expensive, and so complicated in application as to cause a tax which no commerce could sustain, and which would practically work its entire obstruction. So, while I recognize the efficiency of steam, great heat, or intense cold, as agents which all attain with certainty the desired result, I recognize also that their practical application is enormously expensive, requiring complicated machinery and a corps of skilled men, and does not ensure results that are better or more certain than those attained by the more simple processes.

I am fortified by a long experience, and by the fact that from the worst infected vessels no unpleasant consequences have followed where the simple process of aëration, *cleaning*, fumigation and disinfection have been thorough. What I have said with regard to fumigation also applies to disinfection. No elaborate or expensive machine, no high-priced or secret compounds are needed. A solution of sulphate of iron—a pound to the gallon of water, combined with carbolic acid of twenty per cent. strength, thoroughly applied with a common watering-pot, will meet every contingency.

Cholera, transmitted primarily by the individual, and secondarily only by his surroundings, calls for a different series of preventive measures. Appropriate restrictions have occupied the different countries of Europe far more than our own. They are situate much nearer the seat of *endémicité*, and have not the broad expanse of water which we have lying between them and its source. While the same principles of contravention apply equally to our ports against the introduction and limitation of the scourge, we have also an additional element of safety in the measures of repression which should be employed on the vessel itself while in the period of transit.

It is hardly necessary to say that preventive measures are far more difficult of general application than in yellow fever. Each individual attacked becomes in himself a *foyer* for the spread of the epidemic. It is unreasonable to suppose that, with our immense extent of seaboard, and with the different and in most instances lax sanitary regulations which prevail in the ports, the disease, if prevalent in the Old World, shall not find an entrance here. Still, on closer observation, it will be seen that but a limited number of these ports require rigid inspection. The different ports of Canada, Boston, New York, Philadelphia, Baltimore, and New Orleans are the ones to which the principal passenger traffic is directed. If the disease be thoroughly excluded from these, there is comparatively little to be apprehended from the other ports. Another element of difficulty stands in the way of its prevention, viz., that, of all the importable diseases, cholera is the one whose dangers are not limited to certain climates, seasons, and localities. It has none of the remarkable affinities of yellow fever for this or that district or this or that latitude, for there is no portion of the globe which has shown itself refractory to its propagation.

Again, in its mode of propagation and diffusion, cholera does not show that peculiar disposition, characteristic of yellow fever, to limit itself to maritime ports and large centres of population. It passes in every direction where man circulates; and every choleraic stool discharged along the line of a railroad, however far removed it may be from the place where the disease is prevailing, becomes a centre for diffusing the poison. Notwithstanding all these unfavorable conditions, measures of prevention, if intelligently applied, are not as difficult as would at first sight appear. To be effectual they must, however, be systematized before the disease gains access to the shores. Once it has found lodgement in a community, nothing remains but to carry out the most rigid measures of general hygiene, with special methods of disinfection and purification applied to each particular case.

The position of this country with reference to Europe allows the application of the same principles of prevention which Europe now so efficiently uses at the places of propagation of cholera. There it is almost wholly transported by the caravans of pilgrims, which can be kept under surveillance during their slow transit; in the case of this country, however, it must come by passenger-steamers, which for the time being are isolated communities, which can be kept under observation during transit, and in which, should disease appear, it could be stamped out before reaching our shores. Medical officers are now upon all steamers that carry passengers. They should understand that their professional obligations are not limited to the treatment of the sick which may fall to their care, but, on the appearance of any epidemic or contagious disease, their whole efforts should be directed to its suppression. Isolation, purification, and disinfection are all at their command. Each vessel carrying steerage passengers has, in addition to the rooms appropriated to general hospital purposes, another for quarantinable diseases.

Desirable as all these measures may be with reference to cholera, experience has shown that they cannot be relied on, and that provision must be made for the repression of the disease after its arrival in port. A vessel arriving with sickness should be treated as follows : The sick should be sent to hospital ; all other passengers should be taken from the ship and sent to the "quarantine of observation." It is essential that the vessel be cleared of all on board but the crew; all clothing, bedding, furniture, and rooms should first be disinfected and then washed. When the vessel has been detained sufficiently long for this rigid cleansing, and also to determine whether any of the crew will become victims, she may go at once to dock for discharge. Neither the vessel nor the cargo proper would be likely to convey the infection if all parts occupied by crew and passengers had been rendered safe.

A rigid quarantine should be maintained over those in hospital as well as over those under observation. In the case of the former the discharges should pass into some disinfecting fluid ; soiled bedding, garments, cloths of every kind should be thrown into a similar fluid, or subjected to superheated steam before being washed. Attendants should frequently wash their hands, and promptly remove stained clothing.

Those placed at the "quarantine of observation" should have a medical officer constantly in attendance. At the first appearance of a choleraic discharge from any of the number, such person must be immediately removed to the hospital. The same rules of cleanliness and disinfection should prevail here as at the hospital. When a period of four or five days has elapsed without the appearance of any new cases at the "quarantine of observation," the passengers and baggage may have *pratique.* Every article of clothing should be absolutely clean before leaving.

The scope of this article does not call for a recital of the therapeutic measures adopted for the treatment of yellow fever or cholera, simply those which are repressive, and which prevent a further transmission.

Ship fever, as a quarantinable disease, is probably a memory of the past. It is hardly probable that a conjunction of circumstances will again arise such as favored its development some twenty-five years since. Emigrants then reached this country wholly in sailing-ships, oftentimes after passages of sixty and eighty days. A large proportion were at that time Irish, who fled from their homes the victims of suffering and famine. A system exhausted and depressed, the close confinement in filthy and dirty steerages, the poor character of food and cooking—all combined, brought, as a natural result, the inevitable scourge of typhus or ship fever. All this is totally changed, and the disease, so far as quarantine is concerned, is mythical. Should it make its appearance, the same disposition of the vessel, the well, and the sick, should be made as in cholera: the same rules of cleanliness and ablution should be observed. In the case of ship fever, however, the sick should be as much as possible isolated, and the largest air-space allowed, with constant interchange of air. Indeed, should the season permit, *tent* hospitals are far preferable to permanent ones.

The contagion of typhus exhales but a short distance from the patient, and, more than in any other contagious disease, is dissipated by cleanliness and free interchange of air.

A vessel arriving with small-pox rarely requires a longer detention than is necessary for the vaccination of those who have been exposed. When the disease occurs on passenger-ships, the case is to be promptly isolated, and if vaccination then be resorted to, no further cases, in my experience, will occur. Where the disease occurs on a sailing-vessel, it not unfrequently occurs that no effort at isolation is made. Detention is therefore necessary, not only for thorough cleaning and purification of the vessel, but also for the purpose of ascertaining the results of vaccination in the crew. Of course the case or cases of small-pox should at once be sent to the appropriate hospital.

The foregoing considerations are deemed sufficiently explicit and simple to meet any and every contingency. Success will depend upon the faithful application of the measures directed. The executive officer must, in every instance, give his personal undivided attention to the details involved. Indifference and inefficiency are the causes which have brought opprobrium upon the system, causing communities to rest in a fancied security until the pestilence was in their midst. On the other hand, the contravention connected with quarantine should not lessen the activity of all local hygienic measures in a threatened community. The two classes of measures should be regarded as inseparably allied; the more perfect the hygienic condition of a locality, the less will be its receptivity to disease germs; or, should they gain an access, the more feeble will be the intensity and persistence of the disease.

Finally, bring to the consideration of subjects connected with quarantine the same principles of action which govern one in the daily affairs of life: determine first every possible circumstance connected with the incubation and mode of propagation of an epidemic, and contravene it by measures specially adapted to the special form of disease.

INLAND QUARANTINE.

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INLAND QUARANTINE.

In the consideration of this subject reference is had to yellow fever and cholera solely. Though small-pox and typhus are included in the scope of maritime quarantine, there is no danger that either would gain much headway in any well-regulated community, and the plans of internal quarantine about to be described would not be well adapted to their repression.

It is presumed that no one would assert the local origin of cholera in any part of this country, but we must observe that there are in New Orleans numerous adherents to the belief that yellow fever, whatever may have been its place of nativity, has there acquired a permanent abode, and needs no new introduction of specific infection to attain epidemic proportions. Some even go so far as to maintain that the prevalence of this fever in any place is due to "*certain* local conditions," but these conditions have never been defined, beyond rather vague allusions to accumulations of foul organic matters, and therefore they are in reality quite *uncertain*.

If there be any good ground for the indictment against filth, the fever should always spring up, and mostly rage, in foul localities, but such is not the fact; also in these localities the fever ought to prevail every season, but it is not so found. On the contrary, it may be affirmed that every outbreak of yellow fever, whether at New Orleans or elsewhere in this country, is directly or remotely traceable to other cases of the same disease, occurring in some region not visited by frost. The fact that the chain of evidence is sometimes incomplete, only indicates imperfection of research, and does not even establish an exception to the rule.

Here it must be observed that I do not deny the occasional hibernation of yellow fever infection in New Orleans, and possibly other places in the United States, in case of an exceptionally mild winter. This *seems* to have been the case as regards the existence of yellow fever at New Orleans in 1870, 1872, 1874, and 1876; but, though such investigation as could be made by the health authorities failed to establish a chain of connection with foreign infection, the question is not logically settled.

For observe: previous to the governor's proclamation, establishing quarantine against certain named ports, generally taking effect early in

May, vessels having had no sickness aboard, though coming from ports where yellow fever usually prevails, have not been subjected to fumigation nor detention beyond the time necessary for inspection. Thus might be introduced, without any disinfection, a cargo from a port infected by yellow fever, at a time of the year when a summer temperature exists in New Orleans. True, no early or violent outbreak occurs—perhaps none at all; but those who hold that yellow fever has become domesticated among us must not find fault with prolonged latency of the infection, and we should reasonably grant to it a measure of the uncertainty which is universally attributed to scarlet fever.

Again, the theory of "local origin" fails to explain the total absence of yellow fever in New Orleans during particular years. For instance, no deaths are assigned to this disease in 1861. The winter preceding 1861 was severe, and from the month of April a strict quarantine was enforced by the Federal blockade at the mouth of the river and the other approaches by sea. In 1877, after a severe winter, the only case of yellow fever was a passenger on a steamer from Havana, who succeeded in passing the quarantine inspection, being a walking case. Now, though the sanitary condition of the city is said to have been exceptionally good during Federal occupation in 1862, '63, '64, and '65, yet all efforts, sustained by military authority, did not keep New Orleans free of yellow fever in those years; though only eleven cases among the civil population are accredited to the four years, about 100 cases occurred in the U. S. "river fleet" in 1863, and 200 cases on the U. S. gunboats and "river fleet" in 1864. The civil cases of 1862 are said to have been imported, and it is altogether probable that the fever in each of these years was of foreign origin. The year 1876 was marked by a very limited local epidemic of the fever, the origin of which was not traced to a foreign source, and it is to be observed that the preceding winter was unusually mild. The next winter was severe, and in 1877 no case of yellow fever was developed in the city. The only discoverable difference in local conditions between 1876 amd 1877 was that of temperature during the preceding winters.

It appears, therefore, that *temperature* is the only real and efficient constituent in the much-talked-of "local conditions" governing yellow fever, and this is effectually eliminated in regions visited by a killing frost. The whole theory of "local conditions" rests upon the unfortunate fact that a few localities of the United States, particularly New Orleans, are not annually visited by frost severe enough to kill such tropical vegetation as the banana plant, and presumably such living matter as the specific infection of yellow fever. It is significant that this theory is not now invoked where ice annually occurs, and that New Orleans enjoys almost a monopoly of the peculiar "local conditions" which preside over yellow fever.

But evidence to the same conclusion, and of more positive nature, is afforded by the investigations of the Yellow Fever Commission, made during the progress of the epidemic of 1878. They say: "We have not,

in a solitary instance, found a case of yellow fever, which we could justifiably consider as of *de novo* origin, or indigenous to its locality. . . . Quarantines established with such a degree of surveillance and rigor, that absolute non-intercourse is the result, have effectually, and without exception, protected those quarantined from attacks of yellow fever." It appears, therefore, that these absolute quarantines must either have excluded the specific infection of the fever, or suppressed the "peculiar local conditions" which create the disease *de novo;* for the doctrine of chances would not admit such astonishing coincidences.

Thus much has been written in order to show my belief that this fever is an exotic disease, and that every reasonable effort ought to be used to exclude it from our shores. If the idea of its domestication in this country, or that of its dependence on local conditions be admitted, external quarantine is a useless encumbrance, and inland quarantine deserves not a moment's consideration.

Self-preservation is a law of universal prevalence. Among mankind this law is strikingly exemplified in measures adopted to prevent the introduction of pestilential diseases from infected localities. The lessons of the yellow fever epidemic of 1878 in the United States are so recent and so ample, that they will chiefly be used to illustrate the subject at the head of this chapter, and to decide upon the propriety and success of the measure, and how it should be modified.

Toward the end of July, when it became apparent that the disease was likely to assume an epidemic form in New Orleans and to extend its ravages to other points, all communities in direct communication were deeply moved, and there was a spontaneous and general effort to keep the invader from their doors. It is safe to say that those communities which did not adopt repressive measures were mostly actuated by a conviction that they enjoyed, for some reason, an exemption from liability; possibly some resigned themselves to an inevitable fate, believing the infection free as the wind which "bloweth where it listeth."

The investigations of the Yellow Fever Commission, under direction of Dr. John M. Woodworth, Surgeon-General of U. S. Marine Hospital Service, supply most of the facts used for illustration of this subject. Numerous communities, chiefly cities and towns, on routes of travel connected with infected places, adopted such plans of non-intercourse as they supposed to be required by their situation, which were executed with various degrees of rigor and success. For the sake of convenience they will be classified as follows, and considered in the same order: (1), Those places which exercised quarantine against infected localities and escaped yellow fever; (2), those which established quarantine and were severely scourged; (3), those which quarantined and were visited late or lightly; (4), those which dispensed with quarantine and suffered; (5), those which dispensed with quarantine and escaped.

(1). In Louisiana, under this head may be reckoned, on the line of Morgan's Louisiana and Texas Railroad, all the stations, commencing eighteen miles from New Orleans, this side of Morgan City ; thence on

the steamboat and stage route beyond, as far as Washington, 208 miles from the city—twenty-nine places in all quarantined, and all escaping, except six ; on the New Orleans and Mobile Railroad, the stations beyond Scranton ; also Bayou Sara, on the Mississippi River. The following towns extended their restrictions even to the mails (those marked thus * excluding only second- and third-class matter—the others all): Albemarle, Abbeville, Clinton, Franklin, New Iberia, Vidalia,* Waterproof;* also the following entire parishes (corresponding to counties in other States): Bossier, Bienville, Calcasieu,* Cameron,* Caddo, Caldwell, Claiborne, West Carroll, Franklin, Jackson, Lafayette, Morehouse, Ouachita, St. Landry,* St. Martin,* Union, Vermillion, Webster.

In Alabama are included all the stations on the New Orleans and Mobile Railroad and most places in the central portion of the State. The New Orleans mails were excluded by the following places : Bethel, Birmingham,* Cahaba, Central Mills, Cambridge, Clifton, Dumas' Store, King's Landing, Lower Peach Tree, Vaush Creek, Orrville, Pine Hill, Prairie Bluff, Selma, Summerfield.

In Mississippi all the stations on the New Orleans, St. Louis and Chicago Railroad, except Grenada, Holly Springs, and a few unimportant places, enforced quarantine (forty-two in all), and all escaped except nine. To these are to be added Brandon and all Rankin County ; Clinton, Cold Water, Columbus, Duck Port, Leoto Landing, Moss Point, Pascagoula Beach, Natchez, Raymond, Rodney, Sardis, Waterford, and most towns on the Mobile and Ohio Railroad.

In Tennessee and Kentucky, along the Northern Central, St. Louis and Chicago Railroad, quarantine against infected towns was enforced by nearly all the important points, thirteen in all, of which three were visited by yellow fever.

The following places in Mississippi excluded the New Orleans mails: Brandon,* Brunswick, Calvert Store, Fannin,* Fort Stevens, Forest Home, Goodman, Goshen Springs,* Hurricane Creek, Herbert, Midway, Mountain Creek, Pelahatchie,* Pearlington,* Philadelphia, Peter's Landing, Rio, Rushing's Store, Shubuta, Steen's Creek,* Tunnell Hill, Why Not, Woodville ;* also the following counties: Bolivar, Issaqueena, Sharkey, Tunica, Wilkinson.

All post-offices in Arkansas and Texas refused the New Orleans mails. Yellow fever reached four points in Arkansas, and none in Texas.

(2). Quarantine failed in the following towns of Louisiana, which were severely scourged by yellow fever: Allemands Station, Berwick City, La Fourche Crossing, Morgan City, Baton Rouge, Delhi, Delta, Labadieville, Napoleonville, Paincourtville, Thibodaux, Tangipahoa. The following parishes excluded the New Orleans mails, but not effectually the fever: Catahoula (fever at Harrisonburg, as seen hereafter), East Carroll (fever at Henderson), Madison (fever at Delta), Richland (fever at Delhi); also the town of Port Hudson, on the Mississippi. Morgan City is a railroad terminus and the port of the Texas steamers. The quarantine was scarcely more than nominal, and the fever appeared Aug. 17th, being traced to a

sailor from New Orleans. Trains ran through to that city most of the time. At Berwick City (opposite Morgan City) the first case occurred Sept. 27th, and at La Fourche Crossing (a station on the railroad between New Orleans and Morgan City) Sept. 12th, showing a delay of more than six weeks, probably attributable to quarantine. At Napoleonville the infection was traced to goods from New Orleans, and at Paincourtville those first attacked had visited infected localities. The quarantine at Baton Rouge was suspended, to allow the Democratic State Convention to be held there, and the fever appeared there Aug. 10th, a few days afterward. Delta is opposite Vicksburg, and quarantined against the latter place Aug. 25th, two days after which a case appeared at the former. Delhi is a small railroad town between Delta and Monroe, and a case of yellow fever occurred there Aug. 11th, two weeks before Delta quarantined against Vicksburg, in the person of a man from Vicksburg, who had boarded in an infected part of that town. The next cases were attendants on this person. At Thibodaux the quarantine is said to have been merely nominal. At Tangipahoa the introduction of the fever was attributed to three railroad employés from New Orleans, and the first case among the inhabitants occurred Sept. 1st. At Labadieville the infection was traced to goods from New Orleans, and the first case in that region occurred in the neighborhood of the town, outside its limits. It is easy to account for the fever at the above places through defect of the quarantine.

In Mississippi, under this head belong Bolton, Canton, Greenville, Jackson, Lake, Lebanon, Meridian, McComb City, Osyka, Ocean Springs, Port Gibson, Rocky Springs, Vicksburg, and Water Valley. The following counties and towns excluded the New Orleans mails, but did not escape: Coahoma County (fever at Friar's Point), Washington County (fever at Greenville, Refuge Landing, Stoneville, and Winterville); also Bolton,* Jackson, Meridian,* Pearlington,* Shubuta,* and Winona. Bolton is a railroad town near Jackson, in the direction of Vicksburg. The first death occurred Aug. 12th, and, out of a total population of 200, 144 or more had yellow fever. At Canton the quarantine was established too late—only one day before the occurrence of the first case. At Jackson the fever was delayed by quarantine more than a month, while they were exposed to danger of infection from both New Orleans and Vicksburg. At Lake quarantine was delayed twenty-four hours by the mayor, to allow the admission of his son-in-law from Vicksburg, who came in sick with yellow fever. The "Lebanon neighborhood" was strictly quarantined, and the mode of infection has not been traced. It might have been introduced by night-walking negroes, without discovery. At Meridian the fever was introduced by railroad employés. McComb City is a railroad town, where the fever did not appear until nearly the end of September. Osyka was quarantined July 28th, while the first case occurred July 27th. The quarantine at Ocean Springs was openly disregarded. A practitioner of medicine in New Orleans has his family residence at this coast watering-place, and the whole household kept themselves strictly

secluded during the whole course of the fever at Ocean Springs. No one went outside the enclosure, and no one entered but the doctor. All escaped, though there were no less than twelve of the family who had not had the fever. A parallel instance occurred in the environs of Vicksburg. The quarantine at Port Gibson was established after the appearance of the fever. At Rocky Springs one of the town authorities violated the quarantine by bringing in a lot of bagging for baling cotton. The fever broke out in the family of his partner or agent, who took home a portion of this bagging. At Vicksburg the quarantine was loosely carried out. Citizens went without restraint on steamboats, and persons arrived by railroad and steamboat without any opposition. The fever was introduced by some of the crews of the "John D. Porter" and "City of Alton," who were put ashore, and died—one July 24th, another July 25th. At Water Valley the infection was introduced by railroad trainmen, who were allowed to stop over there.

In Tennessee the principal examples under this head are Grand Junction and Memphis. At the last place a death from yellow fever occurred July 21st, a man from the steamboat "John A. Scudder." In Alabama, Decatur is the most striking example. At Tuscumbia quarantine was very lax.

(3). Washington, La., on Bayou Teche, was strictly quarantined, and escaped yellow fever until late in November. Provisions were admitted, but woollen goods were excluded. It appears that the infection was introduced by flannel goods smuggled in a barrel of grits. The fever broke out in the family where these flannels were worn, and extended to their neighbors. Harrisonburg, on the Ouachita River, also escaped until shortly before the appearance of frost. A box was discovered on the bank of the river, about two miles below the town, which was carried in by several young men and opened. It was found to contain some clothing, among other articles. All these young men, with one exception, took the fever. Mobile, Ala., had about 300 cases altogether. Quarantine was enforced, commencing July 27th. It is alleged that a case occurred there August 1st, in the person of a woman who left New Orleans July 24th; and another case traceable to that one, August 10th. The maximum mortality was, October 18th, 25. At Milan, Tenn., the first case was not a resident, and occurred August 26th. The first case among the inhabitants occurred September 18th. The town has about 2,000 inhabitants, and the quarantine is acknowledged not to have been strict.

In Mississippi, Bovina, Byram, Okolona, Winona, and Yazoo City were affected lightly. At Yazoo City the policy of total non-intercourse was adopted. Yellow fever was introduced by a clergyman, who officiated at the funeral of a child in the country six miles off. The child was supposed to have died of a malarial fever, but was afterward discovered to have had yellow fever. Helena, Ark., Cairo, Ill., and Cincinnati, established quarantine and had few cases.

(4). Under this head in Louisiana, Donaldsonville, Port Hudson, Plaquemine, and Gretna, river towns, suffered severely. In Mississippi

are to be named the Gulf watering-places, to Biloxi inclusive, viz.: Bay St. Louis, Pass Christian, Mississippi City, and Biloxi; Handsboro; Pearlington and Logtown on Pearl River; Grenada and Holly Springs; besides other places of less note. In Tennessee, Brownsville and Martin, both railroad towns; in Kentucky, Bowling Green, Danville, Hickman, and Louisville (though not severely).

(5). The following places escaped, though not quarantined:

Five unimportant stations on the Mobile Railroad, within thirty miles of New Orleans, almost totally without inhabitants; also Amite City, La., and several insignificant points on the New Orleans, St. Louis and Chicago Railroad, where there were not inhabitants enough to organize a quarantine. On the Memphis and Charleston Railroad are to be named Saulsbury, Middleton, Pocahontas, Chewalla, Glendale, Burnsville, Iuka (six cases altogether), Dickson, Huntsville (twenty-four cases, only one of local origin), Fearn's, Brownsboro', Paint Rock, Woodville, Larkinsville, Scottsborough, Bell Fonte. To these these may be added Smithland, Ky.

The lessons of the recent epidemic must bring the unprejudiced mind to the belief that there was a clear relation between enforcement of quarantine regulations and prevalence of yellow fever in all threatened communities—that is to say, that there was no security in a loose system, and complete safety in absolute non-intercourse. None but those who have been reduced to the verge of starvation, or suffered prolonged severance of the closest family ties, can fully appreciate the price paid for immunity; on the other hand, observers at a distance must fail to appreciate the situation of a threatened community, confronted by a new and invisible danger. I am convinced that calm consideration of the whole case will lead to the conclusion that no blame should attach to the adoption of the most extreme measures, which were enforced with more than military severity. The warrant for such action was the ancient dictum, *salus populi suprema lex*. In untried and unskilful hands it would be unreasonable to expect great success. The results, with all their imperfections, ought to satisfy a candid mind; while the enlightened sanitarian feels a weight of duty pressing him to find some escape from the danger, and at the same time release from the worst inflictions of the remedy. The most obvious and reasonable deduction from these numerous experiments at internal quarantine is to the effect that there was an almost total lack of system and suitable adaptation of means to the end aimed at, and that the proper course would be, to subject all local health authorities to a central supervision, either state or national. In 1878 Louisiana, it would reasonably appear, was sufficiently punished for a wholesome lesson, but the recent adjournment of the legislature without accomplishing a single measure of sanitary legislation, though no less than five bills of this nature were brought before its notice and favorably reported on by the appropriate committees, speaks very discouragingly for the repression of yellow fever through state action. But, even had the legislature of Louisiana done its full duty in strengthening the hands of the State board of health to exclude infectious diseases from its borders, and to supervise local au-

thorities in the execution of internal quarantine measures, in case of the actual presence of such disease at New Orleans, it is probably too much to expect that the other exposed States, coastwise and inland, would all adopt wise and energetic measures of prevention.

In the national Congress the present outlook is more promising, both from the probability that the people of the other exposed States, especially inland, are more thoroughly awakened to the importance of strenuous measures of repression than the people of Louisiana, and from the fact that men of character and ability far superior to the average State legislator are sent to the Congress at Washington. I shall not undertake here to discuss, still less to decide, the question of the authority of the General Government, under the Constitution of the United States, to legislate or assume any executive functions pertaining to public health. It appears that a great majority in Congress are satisfied of their right to act, either on general principles or because the emergency justifies interference, and I have no doubt that a carefully digested plan of national supervision of external and internal quarantine would greatly conduce to the efficiency of the service.

If Congress should undertake to legislate at all on this subject, it should do no less than provide for the protection of communities either destitute of a quarantine system or possessing one manifestly imperfect in action. In such cases the central authority should be prompt and complete in action. Moreover, close observation should be exercised over all places having well-organized local quarantine systems, whenever they may be threatened by infectious diseases, such as cholera and yellow fever, both to keep the central office thoroughly informed of the actual progress of the disease and of the means in readiness for its repression, and also to afford counsel whenever appropriate or necessary. To this end it would be convenient to divide the country into sanitary departments, or districts, with a competent health-officer assigned to each, and all subordinate to a central authority at the national capital. Particular surveillance should be exercised over internal lines of travel and transportation from infected points, and there should be power to place travel and traffic under necessary restrictions and regulations.

As New Orleans has been the port most threatened by yellow fever, it will be convenient to use this point by way of illustration, with the supposition that the fever has made its appearance in threatening proportions, whether by importation anew or survival from a previous year. The object is to confine the disease within existing limits, and the advantages of an already organized system of inland quarantine, with ample authority for regulating intercourse on all lines of communication, over the various plans adopted in 1878 by panic-stricken citizens, are too apparent for argument. The plan of non-intercourse, though justifiable in case of surprise without previous organization to meet danger, is quite out of harmony with the civilization of our age, in the needless hardships which it imposes; but restrictions must be prescribed, and there must be power at hand for their enforcement.

In my judgment, the scope of repression should be limited chiefly to the neigbborhood of the infected city (say New Orleans), and all the railroads and the river in both directions should be subjected to a strict quarantine, provisional stations for this purpose having been established within a few miles on each route and at some distance from human habitations. At those stations all merchandise should undergo transshipment, together with thorough disinfection by sulphur fumigation in close apartments. The water-craft and railroad cars from the infected city should never come near those travelling to the interior, and should not be allowed to proceed farther than the quarantine stations. The landing-places on the river and the railroad transfer stations should be located on smooth ground, to admit of easy sprinkling with a five per cent. solution of carbolic acid, which should be practised to a distance of two or three hundred feet around daily, or so often as arrivals might occur from the infected city. The sulphur fumigation should be extended to the personal baggage of passengers, and include the opened mail-bags, though there is no well-authenticated instance of the conveyance of yellow-fever infection by mail matters. All boxes and other receptacles of dry goods should be opened and their contents thoroughly subjected to the fumes of sulphur.

As regards detention of travellers, I should say that those who have had the fever should be allowed to proceed as soon as their baggage had undergone disinfection. The quarantine officer must satisfy himself of the fact of the individual's having had yellow fever by the certificate of his attending physician or his own affidavit. Unacclimated passengers should be detained for a period of not less than ten days, as a precautionary measure, for there is ground for the supposition that the yellow fever infection is multiplied within as well as without the human body.

As a further and proper precaution, travellers from an infected town should be required to make an entire change of dress and undergo a complete bath, including the hair. The clothes put on after the bath must have undergone fumigation, and those taken off must be subjected to the same process. This plan would require two buildings, which should be several hundred yards apart; the first intended for disinfection and bathing, the second for residence during the period of detention or incubation of the disease. The ground around the first should be sprinkled every two or three days with dilute carbolic acid, and passengers should not be allowed to return to this building after once leaving it. These buildings need be no more than temporary structures, erected at moderate cost.

As regards outgoing vessels by sea, no interference would be necessary, since the quarantine at each port should be competent for its protection.

In case of an outbreak of yellow fever at an interior city or town, the plan of proceeding should be quite similar. Temporary quarantine stations should be established on all the avenues of approach, and no substances capable of acting as fomites should be allowed removal before thorough disinfection. Persons must be subjected to the same restrictions on leaving infected places as before mentioned. Railroad trains passing through

such towns should never stop, but keep a running speed of not less than ten miles an hour through their limits. Water-craft used as lighters from infected towns to the quarantine stations should have their closed apartments fumigated daily with sulphur, and their decks daily sprinkled with a five per cent. solution of Calvert's No. 5 carbolic acid.

When we have to deal with cholera, the plan of action is somewhat different. In this disease the *materies morbi* is known to be reproduced in the human body, and to be found in the ejections from both extremities of the alimentary canal and from the bladder. The general rules for the establishment of quarantine stations around infected towns are the same as in case of yellow fever, but they are not limited to the warm season. On the other hand, as cholera ought to be effectually stamped out of a town which has a well-organized board of health within a few weeks, the obstruction need not be of long continuance.

The danger of conveying cholera infection through articles passing under the general term of *freight*, on transportation lines, is so small as to be left out of consideration. Packages sent by express would need inspection, and those consisting of personal clothing and bedding should be subjected to sulphur fumigation. Soiled articles must, in addition to fumigation, be thoroughly cleansed. The same rules, as stated in relation to yellow fever, apply to bathing, change of dress, and disinfection of all personal baggage of passengers. The detention of passengers during the period of incubation (at least eight days) must be insisted on, to render the quarantine of any value.

In case any individuals should fall sick, either of yellow fever or cholera, while under detention, they should be sent back as soon as possible to the town from which they have departed, for the station would always be within a few miles, and there would be no time to establish hospitals at an impromptu quarantine station.

It is evident that the execution of such a system of quarantine must not be in the hands of local health authorities, either municipal or State. Nothing less than the authority of the General Government would cause it to be fully respected, and the medical officers in charge must feel that their responsibility is not limited to a city, or even a State. For illustration, suppose the city of New Orleans were again visited by yellow fever or cholera. An inland quarantine would have for its object the protection of the interior country, but the great commercial interests of the city have always opposed external quarantine restrictions, and would be still less tolerant of an inland quarantine. The board of health of Louisiana is a mixed body, the State and city both being represented on it; and at the present time the city is allowed a majority in membership. There has always been a strong disposition among commercial men to ignore or conceal the existence of yellow fever in New Orleans, though within my knowledge the board of health has not countenanced this policy; but the prospect of being shut off from the interior country would bring an irresistible pressure on the city members, and they would certainly fail to recognize the existence of yellow fever and cholera until the diseases had

spread beyond their control, so much do they resemble intermittent fever and cholera morbus.

The foregoing plan, of which only a mere outline has been presented, is without precedent, so far as I am informed. It has suggested itself to me as the best means of obviating the difficulties and failures hitherto experienced, when the repression of diseases naturally infectious and epidemic was left to the threatened communities themselves, guided for the most part by the simple instinct of self-preservation. It is too much to expect that proficiency in preventive medicine will become a common accomplishment, even among medical men, in our day. None save a few public officials have any practical interest in it ; and, under the present mode of organization of sanitary bodies in this country, where rotation in office conforms to political usage, no one can safely abandon curative for preventive medicine.

In addition to superior organization always in readiness to act at the beginning of an outbreak, the above system would enjoy the advantage of earlier and better information of danger, from the presence of health officers in the threatened seaports ; and, besides, it would be far less difficult to prevent the escape of infection from one city than to prevent its introduction to an indefinite number of interior towns. This is especially the case in Louisiana, with its extensive network of inland navigation, all in communication with New Orleans, whereon every contiguous plantation has its own landing. Again, it would obviate the barbarism of total nonintercourse, which was found the only trustworthy plan at inland towns in 1878, and which would be generally adopted with great certainty by most interior communities in case of another outbreak of yellow fever at any of our Southern seaports, unless they were satisfied that no less power than the General Government had provided means adequate to their protection, by arresting the pestilence at the threshold.

Another obvious consequence of some such plan as the one above outlined would be the stimulation of exterior quarantine authorities to greater vigilance, inasmuch as the inconvenience of inland quarantine would be brought home to the people of the coastwise cities; while, on the other hand, intercourse among interior communities would be relieved of all the dread and embarrassment experienced in 1878, so long as the pestilence remained shut up at the city first assailed.

It is beyond dispute that a plan of such novelty and such salient features would meet strong opposition in a mercantile community, and it is not to be expected that it would work smoothly or satisfactorily at first.

Great need would there be for sound judgment and cool temper on the part of the health officers selected to carry out the details, as well as ceaseless vigilance to prevent evasions, in relation both to persons and to fomites.

In case, however, Congress should fail to legislate on this subject, or should so restrict the powers of the national quarantine authorities as to forbid the execution of such a plan as the one heretofore delineated, it is not to be expected that it would be adopted by State or municipal health

authorities. Every community then would be obliged to provide for its own protection. An association of delegates from the sanitary bodies of threatened communities would certainly be desirable, in order to take counsel together and establish some uniformity of action. Well-organized State boards of health, with ample powers and independent of local influences, in interior States, like Mississippi, Arkansas, Tennessee, and Kentucky, might protect their borders from the introduction of yellow fever and cholera by the exercise of due vigilance. In Louisiana the board of health exhausts its powers in guarding the metropolis. No attempt has been made hitherto to associate other communities in the State for common defence against contagion, and there is no visible sign of such action. The same difficulty probably exists in other States with important seaports, and directly in proportion to the magnitude of commercial interests involved; for they are sure to be arrayed in opposition to restrictions for sanitary ends, though this policy is short-sighted and wrong in the end.

The warfare of science against ancient prejudice (in other words, against barbarism) has now to be fought out in preventive medicine, as it has been in the curative branch. In the latter the contest has lasted many centuries, and is not yet finished. The study of anatomy is fairly tolerated in most parts of the country, but experimental physiology is condemned, because it is in the interest of science, and therefore of humanity; while the mutilation and wanton destruction of animals for sport is commended as healthful and manly!

In the absence both of congressional action and of concerted measures by local health authorities, each body must work independently, as heretofore. Then it would be a measure of great utility to publish advice of a suitable character, proceeding from the highest authority in sanitary matters, as, for instance, the American Public Health Association. These local bodies should be taught that the policy of total non-intercourse is both unnecessary and unjust; that the thorough disinfection by sulphur-fumigation of all fomites, including clothing worn by travellers, the complete bathing of all who are allowed to pass, together with the detention of individuals who have not had yellow fever—and in case of cholera all persons—beyond the period of incubation, are quite sufficient; but that all evasions of these necessary regulations must be rigidly prevented.

In case Congress should see fit to provide for an advisory system of inland service, as supplementary to local quarantine regulations, much good might be done by judicious health officers. It should be their duty to keep themselves fully informed about the presence of cholera and yellow fever at seaports, to give timely notice by telegraph to inland communities, and to visit as many as they conveniently can for the purpose of advising them about suitable means for self-protection. Such a position would be no sinecure, and the service might be of inestimable advantage, coming from an expert sanitarian to a community whose only idea of security from threatened pestilence is rigid seclusion from the whole outer world.

An invasion of the Dominion of Canada by Asiatic cholera would de-

mand the exercise of inland quarantine along an extended boundary line, in the absence of a system for confining the disease at its point of access, similar to the one sketched above. Here, again, is apparent the advantage of a corps of experts always ready for action, and answerable for duty in any part of the country on the shortest notice. Even without legal authority to give and enforce orders, their presence and counsel would avert panic, bring order out of chaos, and prevent resort to rash and extreme measures on the one hand, or the paralyzing effects of despair on the other. In other words, the local authorities would be taught to do the right thing in season.

In the foregoing remarks I have expressed preference for a system of inland quarantine derived from national legislation, with the directing authority at the capital, administered by a corps of experts selected for their special fitness, and with powers sufficient to enable them to place barriers around an infected city or town capable of preventing the escape of infection. Be it understood that these views are simply a proposition of *sanitary science*, according to my individual understanding. Their practicability at the present time, according to the judgment of legislators acknowledging responsibility to their constituents, is a different question, which, I fear, would be decided adversely.

The best alternative would be a similarly organized corps, charged with the following duties: to keep the central office and all subordinates thoroughly informed of the existence and progress of cholera and yellow fever; to render assistance and counsel at threatened points, so as to promote their protection without panic, violence, or measures of needless severity. In case Congress should fail to take any action, State and local health authorities will still have the benefit of warning, through the weekly bulletins issued by the surgeon-general of the United States Marine Hospital Service, which have already rendered signal advantages. These authorities ought to form an association for mutual instruction and agreement upon a uniform system of protecting their several communities, and there is a reasonable prospect that measures of greatly increased efficiency and diminished harshness would be evolved.

Preventive medicine is not yet out of its infancy, though this period has been greatly prolonged by stupid opposition, often operating in the name of religion. Quarantine, its first development, originally a forty-days' detention simply, was long restricted to the exclusion of foreign infection, and in this sense has reached a respectable stage of advancement, *at some ports.* Inland quarantine, a recent variation, is still in the first stage of distinct growth, rude, untaught, savage. My object, in the present paper, has been to produce a simple lesson for this child of nature —a little in advance of the alphabet, but a great deal short of a treatise. In the want of authority on the subject, unusual originality of idea has been necessary, for which the reader's charitable consideration is respectfully asked.

SMALL-POX AND OTHER CONTAGIOUS DISEASES.

(I. SMALL POX.—II. SCARLET FEVER.—III. MEASLES.—IV. WHOOPING-COUGH.)

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SMALL-POX AND OTHER CONTAGIOUS DISEASES.

1.—Small-Pox.

We may include under this head two forms of eruptive fever (variola and varioloid), which bear a general resemblance to each other in these respects, viz.: that in both there is a definite *period of incubation*, which usually lasts fourteen days; that both are characterized by a *period of invasion*, expressed by marked increase of temperature, headache and backache, vomiting, and other evidences of a more or less profound constitutional disturbance; and finally, that in both there is an *eruptive stage*, which in the beginning is shown by a primary redness of the skin, followed by a secondary vesication and umbilication, by maturation or drying up of the lesion, and by final desquamation. This stage—*the eruptive*—occupies about three weeks. These two forms of small-pox, viz., variola and varioloid, differ only in regard to the severity of the symptoms, and they are interchangeable, *i. e.*, the contagion of varioloid may produce variola, and *vice versa.* Of the more detailed clinical features it is hardly necessary to speak, except so far as diagnosis is concerned. It is important, however, that health inspectors and others should bear in mind the danger of confounding the eruption of this disease with that of others; and as such a mistake might be followed by the most serious results, it is of the greatest necessity that extreme caution be used.

Resemblance of small-pox to other eruptive disorders.—In some mixed forms of disease it is often almost impossible to say with certainty that the eruption in a given case is that of small-pox. In the first stage of the eruptive fever, before the contents of the pustules become turbid, it may be mistaken for *measles*, *secondary syphilis*, and occasionally for other eruptions. In measles, however, there is a crescentic arrangement which does not belong to small-pox, and the co-existence of coryza, which is so marked a feature of this disease, is never more than a coincidence in small-pox. The first indications of redness are to be found, in the varioloid affections, about the wrist and forehead, while in no other eruptive fever is any such preference shown. An interval of four days, unattended by any characteristic advance in the appearance of the areola;

vesication with umbilication, etc., will make it quite certain that the disease is neither small-pox nor varioloid. In some cases, however, the rash of measles will simulate the form of variola in which the eruption is not pronounced, but even in such examples there is a brightness of color which does not belong to small-pox of this variety, for in the latter there is a bluish tint and usually a train of very severe constitutional symptoms.

The *roseola* of *secondary syphilis* has in many cases deluded the medical man. In such suspected cases it is well to inquire into the question of previous history, and to carefully search for spots which have dried up, for nearly always a copper-colored patch remains; or, if a day or two is allowed to elapse, the whole surface of the body which has been the seat of the eruption will be found to be dusky and tawny. In children various skin lesions of an extensive type accompany the general eruption.

Varicella is perhaps most commonly mistaken for the more severe diseases of the same general character. In this simple eruption, commonly seen among children, but also quite frequently found among adults, as the statistics of most health boards will show, the skin lesion may be so extensive as to be decidedly puzzling. It is not infrequently characterized by umbilication; but here it may be said that this feature of the true disease (small-pox) is not so constant and important as it is usually supposed to be, and therefore is not to be regarded as pathognomonic. A vesicle formed about the base of a hair is not at all uncommon in varicella or other non-febrile diseases, and umbilication is frequently found even when no such explanation for its production is to be discovered. In varicella it is not common to find any spot in the roof of the mouth, while the contrary is the rule in small-pox. In the majority of cases of this simple disease (varicella) the vesicles appear in successive crops, are very variable in size, and irregular; are rarely surrounded by the areola so marked in small-pox; are never confluent, and are usually much more prominent and *drop-like* than in small-pox. It is also the rule to find skin lesions in different stages of development, some being vesicular and clear, others slightly turgid, and still other spots are found which consist of nothing but a dry puckered crust.

A patient seen at a late stage of the true disease often presents an appearance which may be mistaken for that which may be the result of other cutaneous eruptions. Among these may be mentioned that of syphilis, which, however, is much more slow to disappear, and has the copper color of which I have before spoken, or, in the tertiary lesion, a prominent crust. Cases of eczema have sometimes been mistaken for confluent small-pox in its advanced stage, but it is unusual to find so extensive an appearance of eczema, and there is no trace of separate circumscribed lesions.

It is always well to make more than one visit to the patient, if there be any doubt whatever in the mind of the observer, for an interval of twenty-four hours will often greatly alter the features of the case.

Natural history and propagation.—The first introduction of small-pox into America dates back to the year 1625, when the disease was brought to Mexico by a negro slave, and soon afterward spread rapidly

over a vast tract of country. At periods separated by intervals of seventeen or eighteen years thereafter, fresh outbreaks appeared, which during their continuance were very violent and extensive. During the eighteenth century it appeared at various times in different parts of the country, while so-called epidemics are spoken of by Webster as having occurred in Boston during the middle and latter parts of that century, and the prevalence of the disease at Charleston, S. C., at the same time, is mentioned by early medical writers. In New York, Philadelphia, and other of the old cities of the continent, small-pox has been more or less prevalent since the end of the eighteenth century, and an inspection of the health reports of American, as well as foreign cities, show that a certain number of cases of the disease are to be found at all times. The improvement in sanitary administration and the general introduction of vaccination, however, have done much to prevent the frequent ravages.

Its supposed epidemic nature.—It has been the custom to speak of small-pox as an epidemic disease, and, from its pronounced contagious character and its rapid spread, such a conclusion seems at first to be reasonable; but a more careful study of its mode of appearance and extension must convince us that the existence of small-pox—as a disease which is ever *truly* epidemic—is not possible. The belief in its epidemic character has arisen from the fact that it spreads through a large community in a remarkably short space of time, and when the protection offered by perfect vaccination has not been afforded, and in districts where sanitary control has been lax, or when careless management of cases has existed, the disease has raged so furiously as to leave the impression that it was decidedly epidemic. Such was the case in Massachusetts in 1633, when it appeared among the Indians, who perished by hundreds in a very short space of time, and since which time other outbreaks, equally general and violent, have taken place in different parts of the country. In later years the epidemic in Philadelphia, in 1872–3, is an example of this kind. In modern times, since the study of the disease has of necessity become thorough and methodical, it is invariably possible to trace its extension, and this, taken into account with the fact that there is never a simultaneous outbreak in different parts of the country, but that there is always a recognizable spread, even though so rapid as to appear almost inexplicable by the ordinary theory of contagion and exposure, justifies the assumption that its epidemic appearance is after all accounted for, as I have said, by the violence and diffusibility of the poison.

Dr. Snow, of Providence, in an admirable paper, takes the ground I have just gone over, and says: "This wonderful prevalence of small-pox was not at that time (1872–3), and has never been in recent times, general and widespread at the same moment of time, as would be necessary to constitute a true epidemic" (Public Health Reports, Vol. II., p. 417). In every case it will be found that there is a contagious influence, and the disease cannot possibly appear unless the individual has been exposed to contagion in some way. That the outbreak of small-pox in certain places may be so sudden and general as to give the impression of an epidemic is

quite natural, and may be accounted for when we take into consideration the terrible, contagious nature of the disease. Snow reminds us that the 600,000 cubic inches of atmospheric air exhaled by each individual daily, besides the body emanations, the soiled clothing, furniture, etc., are sufficient in themselves to rapidly propagate the contagion, even if great care is taken, and especially if the disease once gets great headway, as it did in Philadelphia and Boston.

The endemic and climatic influences which affect its spread.—With regard to the question whether the spread of small-pox is modified by endemic influences, it cannot be said that conditions of soil or place have any powerful influence in its propagation or development. Only so far as infected districts are concerned does the question of distribution of cases arise. Overcrowding, uncleanliness, and imperfect ventilation predispose to the disease, and an inspection of the health returns of infected localities shows this very markedly. During the years 1872–3 there were 320 cases of small-pox in the city of New York; 122 cases occurred in the most squalid and crowded streets, and 40 of these were in Park, Baxter, and Pearl streets, all of them being thoroughfares of the worst description, closely built up with tenement-houses of the oldest and poorest kind. Many of the patients were Italians, Irish, and Germans, the latter being especially subject to small-pox. Ignorance and superstition seem to partially account for this increased susceptibility of certain nationalities, and the disbelief in and fear of vaccination invite the spread of the pestilence. As an example of the former, it may be mentioned that, among a large proportion of the German population, the month of May is believed to be the only time when the operation of vaccination may be successfully performed; and no matter how close may be the proximity of the person to a case of the disease, he will often refuse the advantages of protection held out, preferring to run the risk. Owing to this serious obstacle, Dr. Tracy found that among the Italians, who dreaded vaccination, many children, five or six years of age, had never been vaccinated, and that when the prejudices of the parents had been overcome, the extension of the disease was decidedly modified.

Small-pox is markedly controlled by extremes of temperature, but it seems to flourish during cool weather, and is usually abated during the summer months, reappearing in the fall, however.

The question of contagion.—The poison of small-pox may be conveyed by the pus and exfoliated epidermis, by the excretions and secretions, or by any substance which takes up or becomes impregnated with these. In the majority of cases, the contamination of clothing is the first step in the transmission of the disease; consequently we find that rags, bed-linen sent to wash, and clothing worn by other individuals, are all *fomites*, while contact with furniture or articles used by other persons is sometimes all that is sufficient to contract the disease. In one case of which I know, small-pox was conveyed by a barber from one of his customers to another. In another case the patient smoked the pipe which had been used by a friend who had recently recovered. It cannot be questioned that many

cases are undoubtedly contracted in street-cars and other public conveyances, especially those in which straw has been placed.

The latency of the contagious element.—Numerous cases are reported which go to show that the poison of small-pox retains its communicability a long time after the original attack. Trousseau cites two instances, in one of which the virulence of the poison and its infectious properties were undestroyed even after many years. In 1854 an English transport-ship, the Wellington, sailed for the East with a regiment of infantry, and shortly afterward small-pox broke out, when she was put back for Plymouth. After, as it was supposed, she had been completely and perfectly fumigated and purified, she was again despatched; but in less than fifteen days the disease broke out anew, and though the vessel was again completely disinfected, and although she had been laid up for several months, a third outbreak of disease occurred. The disease has been communicated even after a longer period. In the city of New York, during the small-pox outbreak, which lasted with varying violence for two or three years, it was found that in certain houses, though every precaution had been taken after the patient had been removed and the bedding destroyed, six or eight months afterward, or during the next season, new patients developed symptoms of the disease, and that, too, notwithstanding the facts that no cases had existed in the interim, and that no known outside contagious influence could be discovered.

In a house in the upper and eastern part of the city a child contracted small-pox in 1876. After the child's recovery the carpets were removed, the walls washed, and the room carefully disinfected. New tenants shortly afterward took possession of the room, and two years afterward (1878) a child was born. When two months old and unvaccinated she became ill, and presented all the features of a well-developed small-pox. As she had never left the room, and as at the time there was no small-pox in the city, but one inference was possible.

A still more prolonged latent period is mentioned by Trousseau. It was in the case of a grave-digger, who, many years after the death of a person from small-pox, was called upon to reopen the grave.

Contamination of air.—The conveyance of germs by means of air laden with the substances detached from the body of the patient is a fruitful source of contagion, though not so common a means of infection as by actual contact. Under this head come the cases which are developed among people who occupy buildings adjacent to carpet-beating establishlishments or places where carpets are cleaned, or rags dusted for paper-making. The disease, when produced in this way, may occur as a result of the inspiration of air laden with particles of desquamated skin, etc. Such transmission must not be confounded with certain so-called miasmatic diseases dependent upon *vitiated atmosphere*, such as typhoid, the malarial fevers, erysipelas, etc. In the former case there is simply a mechanical change, while in the latter there is an aërial decomposition of a kind which so far is not fully understood.

As an illustration of this, I may refer to the cases which occurred a

year or so ago in an apartment house, where the room of the patient communicated with an air-shaft or well-hole. About three weeks after the first patient had been attacked, small-pox appeared among the tenants of other rooms above communicating with the same shaft, *while no other persons* in the house contracted the disease.

Susceptibility, resistance.—It would seem that under certain conditions of the system there is an unusual susceptibility, while under other circumstances there is an engendered immunity which to some extent protects the individual. While it is a great matter of doubt whether, as is popularly supposed, fear plays any part in the easy receptivity of the contagion by the individual, it cannot be disputed that care, worry, grief, and other depressing emotional states so reduce physical strength as to subject the exposed person more strongly to the danger of contagion; but I am aware of no physical state which invites the disease, except it may be the non-protection by vaccination, and the fact that the patient has never had a previous attack. There seems to be some predisposition, so far as temperament is concerned, and according to my own experience, individuals of light complexion, eyes and hair, soft skin and large glands, are more commonly affected than those of the opposite characteristics. Germans, as a race, form a large proportion of the entire number of reported cases; and this seems remarkable when we bear in mind that they all are extremely thrifty, cleanly people, and that the ordinary spread of fomites among them would therefore not be so extensive as among a careless, dirty set of individuals like some others who are not so often affected.

The disease is said to have been contracted by a person who simply passed another in the street, and many other equally insignificant and transient forms of exposure are cited. An example of this kind, which is well vouched for, but difficult to believe, occurred in the city of New York several years ago. A woman, who had not left her room for several weeks before, was taken ill with small-pox. No exposure either of herself or family to the disease could be traced; but she stated that two weeks before she had been attracted to her window (her room being on the first floor) by the shouts of boys, and found that the cause of the excitement was a small-pox wagon which was driven rapidly past the house. In the absence of other facts, the health authorities were reluctantly compelled to accept this explanation. It would seem that the disease may be transmitted from a corpse, and students who have dissected the bodies of persons dead with the small-pox are said to have contracted the disease. In one instance, known in this city, and probably there are others, the friends of the deceased were found at *a wake kissing the swollen lips of the corpse of a person who had died of confluent small-pox.* It has been stated (Aitken) that some idea of the contagious character of the poison may be inferred by the *odor:* that when this is more offensive, the disease is most likely to be contracted, etc. While accepting this view only as an indication of the severity of the eruption and the destruction of tissue, I think it cannot be adopted as a certainty, for how common is it to find violent hemor-

rhagic or confluent cases after exposure to simple varioloid, in which neither the odor, pustulation, nor death of tissue is great, and *vice versa;* or, in other cases, to find the severe forms of disease without eruption give forth no odor whatever. It is a fact fully appreciated by medical men that persons constantly exposed to small-pox very rarely contract the disease. In the case of physicians, health inspectors, nurses, sisters of charity, hospital orderlies, and some others, this is the rule, and of over one hundred persons who have been, to my knowledge, constantly exposed, some of them seeing as many as a thousand cases, I have never personally known of more than one who has contracted the disease; but there are many writers who believe perfect immunity to be extremely rare. In this connection attention may be called to the exemption of certain persons who occupy the same room, and perhaps bed, with the patients, and though sometimes never vaccinated, altogether escape infection.

Management of cases.—The management of contagious diseases in a community necessitates a harmonious and judicious co-operation between the physicians at large and the sanitary authorities, and, unless this exists, but slight control can be exercised over the spread of diseases of this kind. The sanitary bureau should consist of a superintendent, or head, and local inspectors, in sufficient numbers to control each a moderate tract of territory. Besides these there should be a corps of vaccinators, and one for disinfection, as well as an ambulance-surgeon and helpers.

The proper care of patients with contagious disease, especially those affected with small-pox, also necessitates the provision of a hospital at a safe distance from inhabited districts.

The method adopted in the city of New York—and, I think, such a system has been acknowledged to be most perfect—is, substantially, that mentioned above. The details are as follows: The physician in charge of the case is required to report the name and residence of the patient and diagnosis of the disease. When such a notification is received, the inspector of the district in which the patient lives is notified, and he is expected to immediately visit the case and report by telegraph his instructions. Should the patient be found in a house where isolation is impossible, such as a hotel or tenement, and if it is possible to remove him without seriously compromising life, the inspector's telegram directs that the "case be removed to hospital forthwith, and that the premises be disinfected and fumigated." If it is necessary to remove and burn bedding, such an order is included in the dispatch. If the friends of the patient refuse to allow his removal, the inspector notifies the sanitary superintendent of the fact, and another inspector is notified, who makes a "joint report," endorsing, if he thinks proper, what the first inspector has recommended, and then the police are called in to assist. Should there be no need for such a step, and the patient agrees to go, the ambulance is dispatched, and, under the direction of the ambulance-surgeon, the patient is carefully removed to the hospital. The corps of disinfectors next visit the house and carefully carry out a prescribed plan, while the vaccinating corps systematically vaccinate all those persons in the house

and neighborhood whom they can persuade to submit to the operation. In this way the disease is immediately prevented from spreading.

The inspector has other duties as well as those enumerated above. He satisfies himself of the probable origin of the disease, and, upon the acquired information being communicated to the sanitary superintendent, the evidence is investigated by other inspectors in their respective districts. The following series of questions are those asked the patient and his or her family:

Questions to be answered by Inspectors after Examination of a Case of Small-pox.

First.—Where was the disease contracted?

Second.—Has any small-pox occurred recently in the house where patient is sick? If so, when?

Third.—Have of any of the patient's friends recently *had small-pox?* When and where?

Fourth.—Have any of the patient's friends been *sick recently?* When, where, and with what?

Fifth.—Where was the patient fourteen days before his illness? (Be particular about answers to this question.)

Sixth.—Where was patient on the 15th and 16th days before illness began?

Seventh.—Where was he on the 12th and 13th days before illness?

Eighth.—Had the family bought any new or second-hand clothing within three weeks preceding attack? When and where

Ninth.—Have they purchased any bedding, furniture, etc., in this period? What, when, and where?

Tenth.—Had any pedler exhibited goods to the family during the period of probable contagion? Who and when (state residence of the pedler)?

Eleventh.—Has any person visited the patient or the family from a place where small-pox exists? Who, when, and residence of such person?

Twelfth.—Has the patient ever been vaccinated successfully? When? By whom? What proof now exists?

Thirteenth.—Has the patient ever been revaccinated successfully? When?

Isolation.—It is rarely possible to successfully isolate a patient with small-pox, and this is only feasible when the person has been taken ill in a private house, or if he be on the top floor of a tenement-house. In such cases, however, it is imperative that all communication with other members of the family be stopped. The nurse and the physician are the only persons who should be admitted to the sick-room, and all food should be left outside of the bed-room door by some other person in the house. All immediate members of the family should be sent away from home, provided the nature of the disease is discovered *before the end of the third day*, but in any case they should be vaccinated. Children of the family

should be kept from school, and the teacher informed of the fact. This isolation is to be kept up for certainly three weeks, or until the separation of scabs has taken place, and until the apartment and clothing have been carefully fumigated and disinfected.

Disinfection and fumigation.—In small-pox, as well as in other eruptive contagious disorders, it is important that the body-surface should be anointed with some fatty substance which shall prevent the ready detachment of exfoliated substances which otherwise might be carried to a distance and be the vehicle of contagion.

The *excreta* of the patient, as well as the soiled linen, carpeting, and bed-clothing, should be subjected to careful disinfection. A tub filled with warm water, to which has been added sulphate of zinc in the proportion of six ounces to the gallon, and carbolic acid, one ounce to the gallon, should be kept for the reception of underwear, etc. All clothing worn by the patient should be soaked in this solution before being washed, and the floor, etc., should be sprinkled therewith. The rags used by the patient should be burned or dipped in this fluid, and it will be found advantageous to soak cloths in the same, which should be hung in the sick-room. Carbolic acid is better than any agent of which I know for the purpose, and is to be preferred.

After convalescence it is wise to burn all useless clothing, or, if the patient's bed be of straw or some such substance, it should be destroyed in the same manner.

After convalescence the room should be subjected to fumigation, and for this purpose one or two pounds of roll sulphur should be broken up and placed in some old iron or tin vessel, which is to be floated in a tub of water. After the room is vacated, and all living creatures, such as birds, removed, some alcohol may be poured over the sulphur and ignited. The windows and doors should be closed and kept so for half a day. The room, after being aired for several hours, may be then re-occupied.

As an additional means of precaution, saucers filled with a solution of permanganate of potash (an ounce to a pint) may be left in places out of reach of children or others, and the room may be ventilated by leaving the windows and doors open for a few days. In ships these general directions may be modified; and in cases where it is impossible to resort to fumigation as directed, the use of superheated steam, and the disinfectants I have suggested, may be substituted. When it is impossible to supply steam, the maintenance of a high temperature by stove-heat is to be recommended. In some cases the employment of chlorine gas, which is best prepared by a mixture of sulphuric acid and common salt, may be resorted to.

Vaccination and other means of prevention.—The diminution in the death-rate since Jenner's discovery robs small-pox of most of its terrors, and instead of its being a scourge which frequently sweeps over thousands of miles within an incredibly short space of time, it has not for many years been beyond the control of intelligent medical efforts. The death-rate from small-pox in London during the last century was 199,665, of

which number more than half died during the last half (Gregory), and during the last quarter eight per cent. of this number died. Modern statistics show that the modification of the disease by vaccination has been very decided. During the year ending December 31, 1875, there were admitted to the Riverside Hospital, New York, 2,427 cases of small-pox, and of these 674 died. Out of the total number 1,866 had been vaccinated, and among these there were 375 deaths; 405 had never been vaccinated, and among them there were 200 deaths. In the other cases no history could be obtained. Among the vaccinated the mortality was 20.09 per cent, and *among the unvaccinated* 49.38 *per cent.*

The fact has been shown by Mr. Farr's tables that over fifty per cent. of the patients who die are under five years of age, and according to some excellent statistics collected by Watt, of Glasgow, it was found that more children die between the second and fifth years than before these ages, in America; while the deaths were proportionately greater in the cities of Great Britain. It is believed by this author that such mortality is due to imperfect or neglected vaccination at an early age.

The decided influence of vaccination in the modification of the disease is well shown in the statistics of the London Small-Pox Hospital during the severe epidemic of 1838. Of those unprotected by vaccination 295 cases of confluent small-pox were admitted, of whom 149 died, while of those persons who had been vaccinated 56 only presented confluent small-pox, and of this number 21 died. Of all forms of variolous disease among unvaccinated people there were 396 cases, of whom 157 died, while of 298 cases among persons who had been vaccinated there were only 31 deaths. In the city of New York, during the year 1870, when systematic and general vaccination was practised, the mortality from small-pox was 293, and the total number of cases was 1,580, the population being 942,229. In 1878 the population was 1,100,000, and the *number of cases but* 14, *thanks to judicious vaccination.*

The proper management of the disease depends upon a perfect co-operation of the public, the general medical profession, and the sanitary authorities; and promptness in making known the existence of a case is the first necessity. The concealment of cases, and prejudice against vaccination, on the other hand, have much to do with the propagation of the disease as well as with its fatality, and it has been found that it is even sometimes necessary to impose a fine in cases where medical men are lax or neglectful in making known their connection with the case.

The systematic vaccination of a community necessitates the appointment of a corps and the establishment of a bureau. This done, vaccination should be: 1st, *General*—which implies a regular and thorough visitation of every house and family—such a "house to house" inspection being repeated at intervals. A second visit should be made by a competent person, whose duty it should be to examine as to the result of the first vaccination, and, if the operation has not been successful, he should repeat it. The individual should also collect lymph from the arms of persons who have been successfully vaccinated. It has been the custom in

the Health Department of New York to make a third inspection in primary cases, about thirty days afterward, when a certificate is delivered. 2d, *Special:* In the event of a reported case of small-pox, a corps of vaccinators should be immediately sent to vaccinate the inmates of the house, and those of the houses about that which is occupied by the patient, thus preventing its spread in the immediate vicinity. At the same time, schools, factories, and places where many persons are at work who are absent from their homes in the day-time, are visited and the advantages of vaccination offered.

All children over two months of age should be vaccinated except when they are found to be suffering from certain acute febrile diseases, eczema, or infantile syphilis, unless the danger of exposure is great. Teething children come under this rule. If individuals are found who have not been vaccinated for six or seven years, the operation is to be repeated.

Occasionally it will be found that objections are made by ignorant persons; and in countries where compulsory laws are in existence, these protests, some of them very absurd, have formed the basis of many lawsuits; individuals have cheerfully paid the heavy fines imposed, rather than undergo the distasteful vaccination. It is true that in rare cases syphilis has been transmitted by this operation, but such a danger is only possible where blood has been taken up with the lymph, or the lancet-blade of the operator is dirty. No serious results have occurred, to my knowledge, other than those due to carelessness. Among 24,395 primary vaccinations made by the New York bureau, but 147 complaints were made, and of these many were found to be of a most trivial nature. Erysipelas, tardiness of the healing process, etc., follow rough handling, unclean bandages or falls, while bad hygienic conditions, impure air, bad food, and the discomforts of tenement-house life, cause a delay in the healing process. Among the troubles found as a result of vaccination in the 147 cases above spoken of, "unhealthy sloughing and ulceration at the seat of vaccination" was the case in 84 instances; "excessive inflammation and swelling of the arm, and occasionally erysipelas," in 29; "inflammation of lymphatic glands, sometimes resulting in abscess," in 25; "cutaneous eruptions of various kinds," in 7 cases. But two deaths—both the result of erysipelas, one complicated with meningitis—occurred among this number. This, then, is a very good argument against the objection of the non-believers in vaccination. Much of the success of the operation depends upon the quality of the virus used and the manner in which the operation is performed. Humanized virus is undoubtedly more reliable than that taken from the calf, though the use of the latter is not the subject of such prejudice as when the virus is taken from the human subject. This humanized virus, however, does not possess the advantages of the bovine variety, for there is a danger of communication of disease from one individual to another, which cannot as a matter of course occur when the virus is taken directly from the calf. About eighty per cent. of the primary vaccinations with the calf virus are successful. The lymph taken from the vesicle at the eighth day, or as soon as there is sufficient

accumulation, is the best. Scabs are unreliable, and I know of no better method of collecting and keeping the virus than by the quill. Ivory points or capillary tubes, like the scab, are more or less objectionable and unreliable. The charged quill should be kept in a tightly corked bottle, in a cool, dark place.

It would appear from the results detailed that about eighty per cent. of all carefully made primary vaccinations are entirely, or partially successful. If repeated operations are made, it will be found that after the fifth or sixth attempt the virus usually "takes," even though the first vaccination may have been followed by negative results.

The operation of vaccination is successful in aborting or preventing the appearance of the disease if performed before the third day after exposure, though in other cases the vesicle may appear and develop even during the course of the small-pox. The most efficacious method of vaccinating is by the ordinary thumb-lancet, which should be perfectly clean and carefully wiped after use. A number of crossed scratches should be made just deep enough to expose the superficial vessels, for if great effusion of blood occurs, the virus will be washed away. The quill, well charged, but not moistened before, is to be rubbed over the abraded surface until bleeding is stopped, and the virus rubbed off. Needles, complicated instruments, or canulæ and trochar arrangements which force the crust beneath the skin, are unreliable and not nearly so perfect and safe as the old-fashioned lancet, which can be readily cleaned. In a very able article upon this subject, my friend, Dr. Jas. B. Taylor, alludes to the fact that in no case has he known of a nursing child having contracted the disease from its mother when it was vaccinated at once after but one or two days' exposure. Even though the child be taken to the hospital and exposed to patients in different stages of the disease, the vaccination seems to afford perfect protection.

The collection of virus.—It is best to take humanized virus from very young infants who have been submitted to their primary vaccination, for virus from re-vaccinated cases is not nearly so good. It should be taken at the end of eight days, but not if any areola has appeared, for bleeding readily follows even the most gentle treatment, and there is then danger not only of collecting blood upon the quill, but as well of taking up the products of some erysipelatous inflammation. The vesicle should be punctured at its most prominent part, and not at the base; a number of incisions being made to open the numerous little sacs. A clean-scraped quill, which has previously been soaked in water, and cut squarely across, should be brought gently in contact with the exuded fluid, which dries upon it very rapidly. No pressure or attempt at increasing the supply of virus should be made from any one vesicle, and, if blood flows, the operation should be suspended. The flow and appearance determine the exhaustion of the virus supply; and should the color of the lymph undergo a change, it may be considered time to desist from further attempts to extract it.

Compulsory vaccination.—This subject is one which has received an

unusual amount of attention because of the popular excitement attendant upon the enforcement of laws that have met with decided opposition, especially in Great Britain. The English law compels the parents of children, within a period of three months after birth (or, should the parents, through illness or some other cause, be unable to do so, the person in custody of the infant), to take the child to the public vaccinator of the vaccination district in which it lives, who shall vaccinate it at once. A week later it is to be brought for examination, when, if the operation is found to be successful, a certificate is sent to the registrar, and a duplicate is given to the person in charge of the child. Should the child not be in condition for vaccination, a certificate to this effect is given to the custodian, but within two months a second visit is required. In cases where the child is vaccinated successfully by its own physician, a certificate must be transmitted to the registrar. For failure to comply with these regulations, a fine not to exceed twenty shillings is imposed when a child under fourteen years is found who has not been vaccinated. The workings of such a law have been in many respects very successful, though many lawsuits occur from time to time, and there has been much opposition in the way of anti-vaccination societies, which in many instances have paid the fines of obstinate members. The result of this work has been that "nearly three-fourths of the newly-born in England and Wales have been vaccinated," and during the years 1865–1866 no less than 27,903 separate applications were made for virus by private practitioners. Whatever may be the advantages of such a system abroad, it is certainly not suited to our own country, where cosmopolitan prejudices and a republican form of government exist. It has been found, especially in New York, that an appeal to the common sense or fears of the public is sufficient, and that force is worse than useless. The example of others is a powerful inducement to those who hesitate, and many of the ignorant people of the larger cities are impressed by the methodical manner of the vaccinator and the kindly interest which he so patiently manifests. Every year that passes shows an increased readiness upon the part of the lower classes to be vaccinated, and perhaps even in England the persuasive method would be the best, as it unquestionably is here.

II.—Scarlet Fever.

Scarlatina is one of the group of exanthemata, and is a febrile disease, the product of a specific poison, which is reproduced during the progress of the affection.

In addition to the characters which the different members of the group present in common, scarlet fever is almost always attended by sore-throat, which, at times, becomes so prominent a symptom as to establish a distinct variety of the disorder.

On the second day after the manifestation of the febrile symptoms, or sometimes later, a scarlet efflorescence generally shows itself on the fauces

and pharynx, and on the face and neck, lower part of abdomen, and flexures of thighs, very much in the order here given, but eventually spreading over the entire body, and disappearing, by desquamation of the cuticle, from the fifth to the seventh day.

The disease follows a given course, is often accompanied with grave affection of some internal organ, and is very apt to be followed by important sequelæ.

Most writers make three varieties of the disease, viz.: *scarlatina simplex*, in which there are the fever and rash, but scarcely any throat affection; *scarlatina anginosa*, in which, in addition to the fever and the rash, the throat affection is the most prominent symptom; and *scarlatina maligna*, a name which is applied to certain cases of extreme violence, in which the system is at once overwhelmed by the force of the disease, or in which the symptoms evince an extraordinary degree of weakness and want of vital power on the part of the patient.

There is also a fourth variety now recognized, which embraces such cases as present only isolated symptoms of the fever. This form is called *scarlatina latens*. Sometimes there will be sore throat and eruption only; other persons will, apparently, give no symptom whatever of the disorder, yet may possibly be going through an attack, and will have attention drawn to them only when they are attacked with anasarca and have hæmaturia. In such cases the poison makes itself felt on the kidneys alone, and the dropsy which ensues is likely to be more severe, complicated, and fatal than that which follows the regular forms of the disease.

One needs to be constantly on the alert ; for, taken altogether, scarlatina is more variable in its forms and symptoms than any other of the contagious exanthematous fevers, and its dangers are also more difficult to foresee. It is true that, even when the disease has raged extensively, the visitation has been so mild as to be almost without fatal cases; but at other times again it has assumed a dreadful virulence or malignancy, with a most fearful mortality.

It is not always possible in this disease to determine the duration of the period of *incubation*, on account, oftentimes, of the constant communication of the well with the sick; also, though the time of contact may have been established, on account of differences of susceptibility. Trousseau held that it was necessary that the economy should be in a certain state of "aptitude" for the absorption of the poison to take place; and it has happened that, in a given family, weeks have elapsed before all the members have been attacked with the disease, although constantly exposed. On the other hand, many cases, in which the time of communication is exactly ascertained, establish positively that the duration of the period of incubation is sometimes not more than twenty-four hours.

The period of *invasion* is quite as indefinite, although, as a general rule, it is very short. It shows itself by a febrile state, lassitude, headache, and, occasionally, nausea and vomiting. This primary fever having lasted for one, two, or three days, the *eruption* appears. This runs a course of from six to eight days, and is followed by *desquamation*, which

begins with the decline of the eruption, and is normally completed by the end of the second week.

There are certain other points in connection with scarlet fever which it is well to take into account as pertaining to the general history of the disease.

First, with regard to the question of age, it has been said that children have been born suffering with the disease. This, however, is certainly a rare exception. From an inquiry, based upon a large number of cases, it has been shown that the liability is greatest between the ages of eighteen months and six years, especially in the third and fourth years. The liability diminishes with age, however, and even after the fifth year the chances of contracting the disease diminish. In a more general way it can be said that children under ten are especially liable. Up to the age of twenty, males and females are equally affected, and after twenty it is more common in women.

As one would naturally suppose, this disease spreads much more widely and with a larger mortality among the poor than among the wealthy classes. We also find it much more common in large towns than in the country, and it is about twice as fatal in poor, overcrowded districts as it is when the cases are isolated. It would seem as if endemic influences played a small part in its causation or spread. The disease is, perhaps, found to exist most extensively in low districts, and certainly high ground has nothing to do with the spread or existence of scarlatina ; sea-coast towns suffer as well as those situated further inland.

Although scarlet fever is much more dangerous in a grown person than in the young, yet the mortality is greatest in the period of infancy and childhood, viz., from one to five years, and, for the reason stated above, that liability to the disease diminishes with age.

The puerperal state predisposes to this disease and also increases its danger.

Scarlet fever, contracted during pregnancy, is pretty certain to lead to an abortion, and it has even be known to be fatal within a few hours.

It seems to be still an open question whether a woman, exposed during the puerperal period to scarlet fever poison, and contracting a fever, has scarlatina alone, or whether the fever developed is not a combination of true scarlatina and puerperal fever. It is natural to suppose, and the weight of evidence seems to favor the supposition, that in a pregnant woman the state of the blood is such that it must have a positive modifying effect on the specific poison and give to the new fever, when it develops, much of the character of puerperal fever.

Scarlet fever belongs to no special season, yet it prevails chiefly in the spring and autumn.

A person may have scarlet fever a second time, but it rarely happens. Dr. Willan, quoted by Aitken, says that out of 2,000 cases which he attended he witnessed no instance of a second attack. Still there are on record instances of even a third attack, but without mortality; and even death from a second attack is almost unknown, but one case having been reported.

The contagion of scarlet fever is exceedingly active and far-reaching, and yet at times it is uncertain in its action. Many children will contract the disease when every precaution has *apparently* been taken to isolate them, while others again will escape, though most dangerously exposed; and it has been also noted, in the extension of scarlatina, that certain towns are spared or lightly visited by the disease, while in others a great number of cases appear.

The infecting distance, or the limit to which the poison may travel unaided, is exceedingly uncertain also; but experience has demonstrated that it is useless to attempt to isolate children who have the fever in a school or other large institution. To limit the disease, it is essential, in all such cases, to break up the establishment at once. The poison may be communicated directly, or it may be taken up from the atmosphere. It has been inoculated with the serum found in the vesicles of the millet-seed rash, and it has been contracted at great distances from the original source through the medium of "fomites" carried from the infected neighborhood.

It is a specific poison, and always reproduces its like, though it may be associated in the system with almost every other form of poison. It is supposed to be absorbed by the various mucous membranes with which it may come in contact, and may develop within a few hours, or it may lie dormant for several days.

"The disorder had attacked several persons in a large household. When it was fairly over, the house was left empty, and then (as was supposed) most thoroughly ventilated and purified. A year afterward the family returned to the house. A drawer in one of the bedrooms resisted for some time the attempts to pull it open. It was found that a strip of flannel had got between the drawer and its frame, and had made the drawer stick. This piece of flannel the housemaid put playfully round her neck. An old nurse who was present, recognizing it as having been used for an application to the throat of one of the former subjects of scarlet fever, snatched it from her, and instantly burned it in the fire. The girl, however, soon sickened, and the disease ran a second time through the household, affecting those who had not had it on the first occasion." (?)

This brings us to the consideration of the means of conveyance.

As in every disease, some individual part of the body is specially involved, so is it most natural that we should look to this part for the reproduction of the special poison which is the originator of the disease. In scarlet fever we have the throat and skin particularly involved, and experience warrants us in looking upon the epidermis and the epithelium of the mouth and throat as the most common means of propagation. These particles may be carried by the wind for short distances, or may in some manner get into the water drank or into the food eaten. Dr. De Chaumont says he "found considerable quantities of epithelium" in the air of a backyard of a London hospital. Of course, all clothing, rags, etc., are most apt to hold such débris, and must be specially avoided until disinfected. Letters have also been known to carry the poison, and so has

milk. In the latter case it has been supposed that persons ill with scarlet fever, or only convalescent, have been employed in dairies, and that some portion of epidermis or discharge from the throat has been allowed to reach the milk.

In investigating a case, we should, therefore, inquire particularly concerning contact, direct or indirect, with some contaminated person or place. Though so essentially contagious, scarlet fever is less so than measles or small-pox, and there are many more people who resist scarlet fever than there are who resist measles. Very few people, in fact, escape measles, while but a comparatively small portion of our population has scarlet fever, though it would seem otherwise from an inspection of health statistics. The explanation is, probably, that cases of measles are not reported.

It is not possible to accurately limit the time during which the patient's infective power lasts. It is safe to say, however, that it begins with incubation, and lasts through desquamation, attaining its maximum during this process. It is thought that the contagious property is, as a general rule, destroyed or dispersed within a month, though there are many cases which go to prove that it possesses the power of communicating the infection even after much longer lapses of time. It lurks about an apartment, or clings to furniture and clothing for a very long time, even after some care has been taken to purify them. Prof. Flint, in his Practice of Medicine, mentions a striking case in point. Watson, also, in his Practice of Physic, has one which is well worth quoting, as showing how an apparent trifle may be overlooked, and yet prove sufficient to light up a fearful illness with all its first intensity. (See case on previous page.)

Several unusual sources of contagion are mentioned by various writers. Carpenter announces the theory that the contagion may arise from emanations from slaughter-houses or ground fertilized by offal. This is disbelieved in by Thomas (Ziemssen's Cyclopædia, Vol. II., p. 198), who says that in houses where the privies and sewage are being repaired, no increase in the amount of disease is ever perceived, and he believes that the only influence of the offensive odors from ground manured in this way is predisposing.

Epidemic character.—Scarlet fever, like other diseases of the same nature, is apt to occur in "epidemics" in which there are many aggravated cases—the so-called "*severe*" epidemics of Thomas. Another type of a *mild* nature has been described. In this latter form the mortality is light, though the number of cases may be great. This variation is supposed to be due to local influence, though mixed epidemics are not unfrequently seen in which "mild" and "severe" forms of disease prevail in different towns.

The spread of the disease in a community is very irregular. It is rarely sudden, never characterized by abrupt changes, but is gradual. The reported cases are but few at first, and afterward more numerous, while variations in the weekly returns are the rule. A sudden rise in the number or a fall is to be looked for, but the disease seems to wear itself out, taking a very long time for final disappearance.

Scarlatina and measles may coexist in an epidemic form, and Köstlin, a continental writer, has observed in Stuttgart the appearance of an epidemic of measles as a forerunner of scarlet fever, and argues that it is a preparative disease. This does not appear in American statistics, though these show a greater or less coexistence of the two diseases, which vary in proportion.

III.—Measles.

Measles, which is one of the less serious contagious eruptive fevers, has an *incubative stage*, lasting from a week to ten days, though it may occupy a somewhat longer period. This is followed by a *premonitory stage*, or *stage of invasion*, which lasts three or four days or longer, and this is followed by the *stage of eruption*, which occupies about the same period of time. The stage of invasion is characterized by the ordinary febrile symptoms which appear in other diseases of the same general class. There is moderate increase in temperature, bronchial catarrh, coryza, some cough, and other indications of a congested condition of the mucous membrane of the nasal and respiratory passages. The eruption appears at first in the face, the forehead being covered with a millet-seed eruption, which becomes papular, but never prominent. The rash has often a crescentic arrangement which is very marked. It afterward extends to the trunk and limbs in successive crops, meanwhile fading out to some degree above. It is not vesicular, except in severe cases, and is of a bright color, though it is sometimes dark, when it is known as *hemorrhagic*. The color may be removed by pressure beneath the finger, and when such pressure is remitted, the original hue returns.

It disappears, as a rule, very rapidly, a day or two often being sufficient for the appearance and recession of the eruption.

Conjunctivitis, severe coryza, bronchitis, and other like symptoms, usually become more decided as the rash becomes fully developed.

Several varieties of the disease have been spoken of. There is a form without catarrh, one in which the eruption has a bluish tint, and others of milder type, in which the eruption is not marked.

Spread and influences which govern it.—Measles, like scarlet fever, is a disease of infancy, and perhaps deserves more the name of an *epidemic* exanthem than either small-pox or scarlet fever. It is generally very easily communicated to others, and perhaps is more often conveyed by atmospheric contamination than scarlet fever, because of the furfuraceous scales which are so easily and freely disengaged from the patient's body. Like scarlet fever and small-pox, it may be conveyed by articles of clothing, and the virulence of the infection lasts even after a great length of time, though Mayr denies this. The discharge from the nose has been found to carry the poison, and successful experiments have been made by Mayr, who inoculated children with the nasal mucus, and produced the disease. The contagion has been carried by letters. The school-room is the place where the disease is often contracted, and personal contact, or a brief ex-

posure to the air of the sick-room, is sufficient to do the mischief. It seems to be a disease of cold weather, as statistics show.

In the city of New York, the average mortality was as follows for the five years, 1871, 1872, 1873, 1874, and 1875:

Mortality for the Summer quarter	....	81.4.
" " Autumnal "	....	35.5.
" " Winter "	....	106.2.
" " Spring "	....	109.6.

This agrees with the statement of Aitken, that measles "break out most readily in the beginning of winter, increase till the vernal equinox, and then tend to subside toward the summer solstice."

Like other diseases of this class, it has been found that one attack usually protects the patient against a second; and this is the rule, though occasional exceptions have been met with.

Nature of the poison—Inoculability.—Numerous experiments have been undertaken to determine the inoculability of the poison; but such negative results were obtained, that the process was abandoned. Dr. Salisbury advanced the theory that a fungus was formed among mouldy straw, and that this was the cause of the outbreak of measles among soldiers during the late war. He went so far as to promulgate the theory that inoculation with this fungus produced a disease which protected the person against measles (Parke). Dr. Woodward, in a series of experiments, has been unable to endorse Salisbury's conclusions. Various German experimenters are said to have found micrococci in the sputa and blood of patients with measles.

As far back as 1758, an attempt was made by Home, in Edinburgh, to inoculate with the blood of patients suffering from measles. Rags soaked in blood from a person sick with the disease were suffered to lie upon the arm of a healthy person for three days. A mild attack was subsequently produced. In Germany, Italy, and England, inoculation was tried, but generally with indifferent success. As a prophylactic measure, however, it has never been successfully applied.

IV.—Whooping-cough.

This affection is one of a somewhat peculiar nature, as its striking symptoms are those indicative of respiratory disturbances.

Whooping-cough begins usually as a common cold or primary catarrhal affection, which lasts for a period varying from one or two days to six weeks, and is expressed by sneezing, chest oppression, profuse lachrymation, and some fever, which is often quite high.

With the subsidence of fever the patient becomes troubled with the peculiar cough which has given to the disease its name. There is at first a feeling of oppression in breathing, with some chest pain, and then fol-

lows the paroxysm of coughing. Such a cough consists of a primary sharp and sudden contraction of the diaphragm with forcible expulsion of air from the lungs; a secondary relaxation of the diaphragm and deep inspiration, during which the peculiar *whoop*, or sound, is made by the patient. This action is repeated several times in succession, or, after an interval, occurs again, and the sufferer coughs up some glairy mucus. A paroxysm of coughing is usually followed by the vomiting of the same thick, viscid liquid mixed with the food that may be in the stomach. There may be an admixture of blood, from some vessel broken during the coughing fit. Such paroxysmal attacks may in severe cases recur every fifteen or twenty minutes; but in the average case the interval is much longer. The stage characterized by the appearance of the cough lasts usually for five or six weeks, when the paroxysms grow weaker and are separated by longer intervals. Gradual convalescence, attended by slight cough and expectoration, and cessation of vomiting, then follows.

The cough is so peculiar that it can hardly be mistaken for that of any other disease.

The nature of the poison and its diffusion.—There can be no doubt that whooping-cough is due to the reception into the system of a poison which, if not possessing the virulence of those of small-pox and scarlet fever, is quite easily transmitted from one person to another by infection or contagion. It is probably communicable during all stages of the disease, but most so during the second stage; and the contagion is probably given off by the breath. One attack usually protects against another. The disease is generally spread by infection, though the transmission of the poison may take place by clothing or other fomites, as is apt to occur when boys return from infected schools, carrying the disease to members of their own families at a distance. Coldness and dampness favor its development; and the accidents of childhood—dentition, foul air, and imperfect nourishment—all predispose to the development and spread of the malady. During the winter season it is quite apt to be associated with pneumonia and other pulmonary diseases.

Its complication with other contagious affections.—It is a matter of speculation whether whooping-cough does not belong to the class of diseases which include epidemic influenza and hay-fever in the human subject and the so-called epizoötics among animals. The features of the so-called pleuro-pneumonia, which in this country has recently appeared among cattle, resemble very much those of the ordinary whooping-cough of infancy in the human subject. During the years 1872–73 a well characterized epidemic of epizoötic influenza prevailed very extensively throughout the United States, and at the same time whooping-cough was quite prevalent; and the mortality during 1872 was twice as great as in 1873, and much greater than in any subsequent year. Scarlet fever, measles, or small-pox is sometimes associated with whooping-cough; but such complications are fortunately rare, for they are correspondingly fatal. It has been found that when the disease prevails to any great extent, the mortality is higher than when but a comparatively small number of cases

exist, and that the death-rate is much higher in winter than in any other season.

The Sanitary Management of Scarlet Fever, Measles, and other Contagious Fevers.

Many of the general rules for isolation, which have before been spoken of in connection with small-pox, may be applied in the management of the above eruptive disorders, especially scarlet fever, which is probably a much more serious contagious eruptive affection than any other. Children with scarlet fever should be promptly taken from school, and kept at home for certainly one month after the appearance of the initial stage. Other children should be kept away from the patient, and the visits of friends discontinued. A large, warm, airy room, at the upper part of the house, should be chosen, and this should be well ventilated.

In case of death, public funerals should be forbidden, and every precaution should be taken to prevent the intercourse of servants or members of the household with persons outside of the house.

Dr. Budd has shown that the way to prevent the spread of scarlet fever is to attack the skin from the very first, to destroy the poison in the epidermis, or, failing in that, to prevent the breaking up and passage into the air of the particles of the detached epidermic scales. Inunction with lard, vaseline, or some substance which should contain a small portion of carbolic acid, is to be performed as often as is necessary. This is not only a soothing application, but prevents the detachment of cutaneous particles.

The liberal use of disinfectants in the sick-room is absolutely necessary. For this purpose carbolic-acid solution (a drachm to a pint) is to be used freely, and may be added to the water in which clothing is washed. Condy's fluid and sulphate of iron placed in shallow vessels are excellent oxidizing agents, and the floor may be sprinkled with a solution of bromo-chloralum. The throat and mouth of the patient may be washed with a weak solution of the chloride of soda or sulphurous acid.

The agency of heat should be sought when it is desired to destroy the germs in clothing, and the bed linen or wearing-apparel of the patient should be soaked in hot water or baked in an oven. Fumigation is generally all that is required during convalescence, and we may use sulphur in the manner detailed on page 523. Parkes states that 1 lb. of sulphur to say 1,000 ft. of cubic air space is necessary.

As to washing the walls, little is to be said in addition to what has been before stated.

Soiled clothing should never be transported in public conveyances nor sent to public laundries.

The same directions hold good for *measles*. The vessels which are used in the sick-room should contain some disinfecting substance, and

chloride of zinc has been recommended. The chloride of soda is equally good, if not better, and its use is attended by no great danger of accidental poisoning. The rags used about the patient's nose and mouth should be promptly burned.

As to the sanitary management of *whooping-cough*, little is to be said. Isolation is probably the only safe precaution, and so long as the pathology of the disease remains a matter of doubt, as it is now, we cannot suggest other preventive measures. It is well to destroy the cloths used about the face, as above recommended. In many cases free ventilation has checked the spread of the disease in certain houses, and this is to be advised.

Prophylaxis.—Beyond a good sanitary condition of the patient and his surroundings, nothing is known in regard to such prevention. Inoculation is decidedly questionable, and vaccination, which was recommended as a preventive in whooping-cough by the older writers, is useless. Belladonna, so much praised by some, has not been proved to possess any prophylactic virtues against scarlet fever. In all cases children should be prevented from kissing each other indiscriminately as they so often do. They should be kept from places of amusement at times when these diseases prevail. All soiled linen should be washed and laundried at home. Warm clothing, protection from draughts, and avoidance of sudden changes of temperature, are to be recommended, and it is well in time of "epidemic" to even move to other towns if the cases of disease in the immediate neighborhood be at all numerous.

THE HYGIENE OF SYPHILIS.

BY

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THE HYGIENE OF SYPHILIS.

Introductory.

In presenting the facts contained in this brief paper upon an important subject, I shall, I hope, be excused for prefacing them by a few words of explanation. The sole apology I have to offer—if apology be requisite for intruding a subject which, even at the present day, is considered as tabooed, and which, from sentimental or other grounds, is regarded as unfit for legislation or repressive action—is its importance, and the shocking results flowing from its ignoral, to the well-being and interests of the public health.

Very few people outside of the medical profession realize, or indeed know, how insidiously the disease may attack, or in what apparently innocent ways it can be contracted or propagated; and in this article I shall try to show some, if not all, of its dangers, and review the means adopted for its restriction. I do not propose to commit myself to the approval of any plan or method looking to this end; for what in one country may answer well enough, will not in another, from a variety of circumstances; and because at present I regard the question of the repression of prostitution as far from being settled. I shall, therefore, consider the subject under the following heads:

1. The contagious character and danger resulting from the disease.
2. Its effect upon health and longevity; and,
3. The means adopted for its control.

The Contagious Character and Danger resulting from the Disease.

Apart from its capacity of propagation by coitus, there are many methods by which the disease can be conveyed by the syphilitic person to others, and that too in the most innocent ways. Not only in the primary form is syphilis contagious, but many of its subsequent manifestations are also dangerous. It is now clearly shown that the secretions of the lesions known as mucous patches of the mucous membranes and of the skin are

endowed with the power of infecting healthy persons; and, in addition to these, the blood, within the first twelve months of the disease, if not longer, is another source of danger. Hence we can readily see that where these "mucous patches" are seated upon the lips or upon the tongue, kissing, using articles of the table, a pipe, or anything else which has been brought in contact with these lesions, may, under certain conditions, give rise to a similar disease in a previously uninfected person; and the pages of medical literature abound with interesting cases of contagion derived from such sources. In addition to the above-mentioned causes, I may mention the following: the suckling of a healthy infant by an infected nurse, or, *vice versa*, the suckling of a syphilitic infant by a healthy nurse, has been the means of spreading syphilis through an entire family, and even to the friends; vaccination with impure matter derived from syphilitic subjects, especially when mixed with the blood; the rite of circumcision as performed in the old and orthodox Hebrew manner mentioned by Ricord; and the process of tattooing. This last case, reported by Dr. Maury, of Philadelphia, is a peculiarly singular one, and calls attention to a hitherto unnoticed method of conveying syphilis through an extensive range of cases. A tramp, the subject of syphilis of the mouth (mucous patches), picked up many honest pennies during his summer jaunt by tattooing the natives of the various villages through which he passed, leaving behind him, besides his artistic designs, an unpleasant reminder of his sojourn by giving syphilis to many of his patrons. This was done through the saliva, which he used to wet his paints, being mixed with the secretions from his mucous patches, as well as from his moistening his needles directly with his lips.

No one who sees much of syphilis can fail to be impressed with the dangers which arise to the public health from this disease; and the daily large attendance of syphilitic patients at the clinics of the dispensaries and hospitals of this city attest to its wide spread. Not only is this visible in the classes and wards devoted to this kind of disease, but its ramifications can be traced in various directions where many diseases apparently unconnected with syphilis owe their origin to this detestable and horrible scourge.

In 1874 I had the honor to read before the American Public Health Association, at Philadelphia, a paper calling attention to the relations of syphilis to the public health, in which, from investigations of various sources, I estimated that in 1873, out of a population of 942,292 persons, 50,450 were suffering from syphilis in New York City. I believe this number to be under rather than over the true amount; but, be that as it may, it is sufficient. This represents only the civil population. The report of the Mercantile Marine of New York City shows a still worse state of things. During 1872 and 1873, the total number of patients treated was 24,645, and of this amount 3,779 were due to syphilis. If *all* the *venereal* cases are considered in the above sets of figures, the number becomes still larger: for New York City, 61,705; for the mercantile marine service, 4,170.

In collecting figures for the purposes of illustrating this subject, it is impossible to be aecurate; all that ean be hoped for is a tolerably correct estimate; and this is evident when the diffieulty of obtaining trustworthy returns from inaccurate registers is remembered. Still, with all this, my figures are of some serviee in showing how widely spread syphilis is in this city, more so than in Paris, where efforts are made to keep the disease in check. The figures given by M. Leeour, who in 1870 was one of the ehiefs of the prefeeture of poliee at Paris, are 48,980 syphilitic persons in a population of 2,000,000 people.

Left, as this disease is, to itself, without any attempt to cheek or control it, the thought that in this city 50,000 cases are going about, many of them in a eondition favorable for eonveying the disease, is an appalling one. Nor is this all ; for when we eonsider that infection, when eonveyed to the wives of the vietims, as not unfrequently is the ease, means the blighting of the ovum and death to the fœtus, it beeomes a serious question whether the state is not justified in interfering in behalf of the publie health.

In the paper already mentioned I have given a set of tables showing that, in a given number of eases of inherited syphilis, the proportion of deaths to those born with the disease was enormous. Thus, in 1871, in London, the percentage of deaths under five years of age to total of deaths from syphilis was over 89. In New York and Philadelphia, for the same year, they were respectively over 84 and 63. Here, then, we see one of the most disastrous effects of syphilis; for although at present the number of syphilitie infants is in small proportion to the number of births, the mere faet that so many are born with and die of a disease which might in a great measure be prevented, hardly needs comment. As regards the aequired form of the disease, the mortality is less to be deplored; indeed, statisties furnish us with very few deaths from that eause, possibly due to the disgraee attaching to this disease as a cause. Many physieians believe that a mueh larger proportion of deaths is due to syphilis than really appears; and although this may perhaps be true, there is not sufficient evidenee as yet to attest it. I am inelined to believe that the danger to the publie health arises more from its effeet upon the eonstitution than from the fatality whieh characterizes it—I mean in its acquired form. In the inherited variety its fatality is very marked.

Its Effect upon Health and Longevity.

As regards this point in the natural history of the disease, I think there is mueh ignorance. Syphilis is essentially a ehronic disease, is liable to attaek every tissue in the body, and its later manifestations often appear so long after the early symptoms, as to cause its eonneetion with many diseases to be overlooked. Thus, grave and deep-seated affections of the eye, serious lesions of the nervous system, and many maladies of the viseera depend upon this disease as their origin, and yet are overlooked, either because the earlier syphilitic symptoms have escaped notice or be-

cause the patient has been ignorant of their connection with syphilis. And yet these same diseases may be sufficient to incapacitate men from work, to blast their lives, and make them dependent upon the charity of friends or strangers, without affording them the miserable gratification of release by death. Any surgeon can recall such cases from his own experience, and the mere fact that they do not occur more frequently than they do offers no excuse for the failure to take measures looking toward the repression of the disease. Its effect upon longevity (I refer of course to the acquired form) is, as already stated, quite small. For example, in London, during 1871, the number of deaths from syphilis was 352 in a total of 80,434. In New York, for the same year, 142 out of 26,976; and in Philadelphia, 19 out of 16,993. That is what official documents furnish us, and until we have something more trustworthy, I suppose we must consider these figures as fairly correct. So, in regarding this question of syphilis in relation to hygiene, we must take into account principally its ravages among infants and its expense to the community at large.

Means adopted for its Control.

In nearly every country of the civilized world, with the exception of England and the United States, legislative methods have been adopted for the repression of prostitution and its attendant disease, syphilis. In these two countries, from sentimental reasons, no systematic efforts have been made looking toward supervision of prostitutes, with the result of allowing the disease to spread unchecked and to render the names of their two chief cities a by-word among foreigners for the license which is allowed. But apart from any question of sentiment, the problem becomes an exceedingly interesting and complex one, for evidently the object of supervision is to eradicate the disease, or at least to deprive it of much of its capacity for mischief. One point to be borne in mind in considering the action of European countries in this direction is, that the conditions of society are entirely different. Nearly all of them keep up large military establishments, where the men are under more or less complete supervision, and where the source of their disease can as a usual thing be easily traced. Anything affecting the health of these men of course makes a difference to the state, inasmuch as during their illness they render no service and are merely an expense, and the state, from motives of interest, would do its best to promote their health. Hence the registering of public women becomes an important and necessary step, and particularly so among that class most frequented by soldiers and sailors, and for two reasons: in the first place, by frequent examinations to prevent the recurrence of disease; and, in the next place, to control its spread when present. But with all the care and precautions taken, much disease exists even in the city most noted for its efforts for control, as can be readily seen upon perusal of M. Lecour's work "La prostitution à Paris et à Londres." Most of this trouble comes from the class of clandestine

and not from the registered women, and it is this former class which is the most dangerous and the most likely to prove refractory to all legislation. In England the brief operation of the Contagious Diseases Act seems to have worked fairly well in the ports in which it has been tried; while in St. Louis, the only city in this country in which it has been tried, its operation has been too spasmodic and of too short duration to be of much account. In discussing any plan for the regulation of prostitution, one important point should be borne in mind, viz., that no known system of control has ever yet eradicated the disease. All that can be hoped for is to mitigate the severity of the disease, to keep it within certain limits, and to check its extension. In garrison towns or at naval stations a proper control over public women would be of decided benefit to the service, inasmuch as the disease could be arrested by the detention in hospital of the woman giving it, and this could easily be effected, either by the information derived from the patient or from the weekly examination to which all public women are subjected under such circumstances. But in a country like the United States, which does not pretend to be a military nation, and where there exists such a tender regard for the liberty of the subject, the advantage of such legislative control is open to question, particularly when we remember the abuses which might arise in the hands of dishonest or negligent officials. I think that New York would be undoubtedly benefited by a proper law looking to the regulation of public women and to their detention in hospital when found diseased, and this rule should be extended to all such who by attendance upon the public hospitals or dispensaries can be considered as objects of public care. But there is one danger to be apprehended in this regard: many women would refuse to enroll themselves as the inmates of a regular house, preferring to live in their own quarters, and, while nominally pursuing some trade, really practising clandestine, and, therefore, dangerous prostitution. In Paris a woman of this class, upon being arrested for the first time, is taken to one of the prefects of police and given her choice of returning to an honest mode of life or inscribing herself as a registered prostitute: if she elects the former, she is sent home to her friends; if the latter, she is inscribed, and henceforth has to submit to the regular examinations and police regulations. If, on the other hand, she be caught a second time as a clandestine prostitute, no choice is given her, and she is obliged to become enrolled. Here in New York the police quickly acquire a knowledge of the rough and dangerous characters in their precinct, and could speedily check, if not actually break up, the vast amount of clandestine prostitution which now goes on in this city. There is one point, however, which may be urged against the adoption, certainly at the present, of any legislative interference with this evil, and that is the extreme liability of abuse. The power which would be conferred by any act of this kind would be enormous; and certainly the conduct of officials in the United States is not such as to induce the public to place any more power in their hands than is absolutely requisite, and for that reason, if for no other, I think that legislative interference in this direction will meet with but slight ap-

proval. For the checking of such cases as might occur of a similar nature to the one related by Dr. Maury, power might be conferred upon the police to arrest all vagrants on suspicion, have them examined, and, if found diseased, committed to hospital until they were well; but as regards the important part of regulating the public commerce of the sexes, but little will, I believe, be accomplished until a decided change takes place in the feelings and customs of the country.

DISINFECTANTS.

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DISINFECTANTS.

Among the numerous diseases to which human beings are subject is a certain class known as zymotic, supposed by many to be caused by the introduction into the system of certain germs of vegetable origin and nature. Without here discussing the questions involved in the controversies respecting the germ theory of disease,[1] it may be safely asserted that some close connection exists between the diseases called zymotic and the presence of decomposing animal matter.[2]

The process of decomposition is of the nature of a fermentation, fostered by the presence of minute organisms.[3] Although all decompositions of the sort may not at all times produce disease, still the presence of decaying matter (especially of animal origin) aids the spread and maintenance of a zymotic disease in a community.[4] This fact has been observed from ancient times.[5]

The bad odor from putrefying material constitutes something of a safeguard to warn us of the presence of possible danger; but, since infection may perhaps exist without perceptible odor, that indication cannot be implicitly trusted.

The gases produced by decomposition are composed of sulphur compounds, of which sulphuretted hydrogen (hydrosulphuric acid) may be taken as a type, ammonia and other nitrogenous compounds similar in constitution, carbonic acid gas (carbon dioxide), and in smaller amounts various compounds of hydrogen with carbon and phosphorus.[6] So far as our knowledge of these compounds goes, none of them (though more or less unwholesome) can produce diseases of the zymotic type. In the examination of disinfectants, the power of destroying or absorbing these gases is always taken into consideration, and if we consider that their presence in the atmosphere above putrescible material indicates that

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[1] Vid. Dalton: Origin and Propagation of Disease, Am. Chem., IV., 373.

[2] Coze and Felz: Recherches chimiques et expér. sur les maladies infectueuses, Paris, 1872. Davaine: Bull. acad. méd., Sept., 1872. Liebig: Chemische Briefe, 1865. Frankland: Proc. Royal Soc., Vol. XXV., p. 542. Fischer: Dingl. Polyt. Journ., CCXIV., 477, etc.

[3] Cohn: Beiträge zur Biologie der Pflanzen, 1872, No. 2, p. 127.

[4] R. Angus Smith: Disinfectants, Edinburgh, 1869, p. 20.

[5] Digesta. Just., Lib. XLIII., tit. 23, and elsewhere.

[6] Manumène: Comptes rendus, LXXXV., 532. Popoff: Arch. für gesammt. Physiol. der Menschen und Thiere, Vol X., p. 113, and others.

putrefying processes are going on, and from these processes we have to fear the inception of disease, the estimation of disinfectants in accordance with their powers of deodorization will not appear altogether irrational.

The conditions of human life are such that we are continually exposed to these dangers, and when any one falls a victim to them the danger is augmented, since the virus of infection appears to gather increased virulence from its passage into the animal organism.[1] What we need, then, is, first, preventive measures, such as properly constructed sewers, etc.; but, if these cannot be obtained, or if they are improperly constructed, some agents to destroy or lessen the dangers referred to are necessary —in short, we must use disinfectants.

By a *disinfectant* is meant, first, a substance which destroys or renders inert that which produces disease, whether of an infectious or contagious type; and, secondly, a substance which arrests those putrefactive processes in decomposable material, which foster or perhaps produce the germs, gases, or vapors that induce disease in the human organism. An *antiseptic*, on the other hand, is a substance which prevents decay in material that is liable to decomposition. From this it will be seen that the use of disinfectants is upon material already in process of forming germs or gases which may be dangerous to the well-being of man, while antiseptics are used upon such substances as may pass into that state, but as yet have not done so. The use of vinegar, alcohol, sugar, and salt in the household, as well as drying, the employment of cold, and the exclusion of air, are familiar examples of the application of antiseptics. So also is the use of corrosive sublimate (mercuric chloride), and arsenic in embalming, as practised at the present time, and in the preservation of medical specimens. All disinfectants are necessarily antiseptics in their action, and possibly sufficient quantities of antiseptics will also act as disinfectants. The mercury and arsenic compounds just mentioned are very powerful disinfectants, though they are almost exclusively used as antiseptics. Indeed, unless disease or putrefaction actually is present, disinfectants are used for their antiseptic action, and their use in that way is by far the most advantageous.

Since the masses of material which we may have occasion to disinfect are usually large, we naturally seek out those substances for disinfectants of which a comparatively small amount will exert a disinfecting influence upon considerable quantities of material.

The disinfectants at present in use are all more or less poisonous; some indeed so poisonous that the mere handling of them is a source of danger for those unacquainted with their properties or the precautions necessary in handling them.

The destruction or removal of animal refuse and excreta is no doubt the safest plan; but since such destruction or removal may not be at all times possible in a household or community, the question arises, how can

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[1] Gietl: Gedrängte Uebersicht meiner Beobachtungen über die Cholera vom Jahre 1831 bis 1873, Munich, 1873. Onimus: Bull. acad. méd., Sept. 17, 1872.

the putrid fermentation be prevented? This involves the question of the conditions favorable or necessary to putrefactive changes. These conditions have been found to be the presence of moisture,[1] a temperature not under 55° Fahr. or thereabouts, and not over 100° F.,[2] and a certain proportion of oxygen[3] combined with a certain freedom of motion of the atoms in the putrescible mass.[4] The process of drying putrescible material will therefore prevent putrefaction. Even if putrefaction has commenced, it may be arrested by this means. But since it has been proven that dried material may again enter into decomposition, as soon as the moisture and the other conditions are restored, desiccation cannot be regarded as any other than an antiseptic process which suspends the vitality of the organisms taking part in the putrefactive changes. A further illustration of this is afforded in the results of experiments upon the virus of some communicable diseases. The virus of vaccina, glanders, and a few other diseases have been found to retain their powers for an indefinite time when dried.

Extremes of temperature also interfere with and arrest putrefactive changes. The limits of temperature given, 55° to 100° F., are of course only approximate. The use of cold as a preservative for articles of food is so well known as to require but a passing mention. Freezing, however, like drying, has been found to cause a suspension of animation in the organisms of putrefaction, and when warmed they again start into activity. It is barely possible that prolonged exposure to very low temperatures may kill these organisms, but no satisfactory results have been obtained as yet in this manner.[5] Heat, on the other hand, when carried to a certain point, has been found to be fatal to such organisms. Here the element of time plays a certain rôle. A short exposure to a comparatively high heat, or long exposure to a lower temperature, has been found to destroy infectious or putrefactive organisms.[6] A résumé in tabular form (see Tables on following page) of some results arrived at in this connection may serve for illustration. At the same time it shows the difference in effect between dry and moist heat as an important element in the process.

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[1] Davy: Phil. Mag., 1856. Rogers: Dingl. Polyt., CXI., 318. Salmon: Ibid., LVI., 398. Soldau: Notizblatt des Hannov. Gewerbever., 1845, No. 3, etc.

[2] R. Angus Smith: Disinfectants, Edinburgh, 1869, p. 56. Schutzenberger: Fermentation, International Sci. Series, p. 220.

[3] Traube and Gscheidlen: Beiträge der Allgemeinen Zeitung, 1874.

[4] Liebig's view (Chemische Briefe, 1865) of the propagation of putrefaction and disease was that it took place through the medium of organic decomposing matter capable of communicating its action by its own activity. The idea contained in this statement of his views is not altogether in accord with the germ theory of which Pasteur was the great exponent, yet all students of the subject have recognized the fact that the instability of a compound, and hence a facility of motion of the atoms composing it in respect to their neighbors, is a necessary condition of putrefaction.

[5] The destruction of cholera, when epidemic in a community, by sharp frosts, is worthy of attention in this connection.

[6] Roberts: Phil. Trans., 1874, Part II.

VIRUS, ETC., DESTROYED.

Virus, etc., experimented on.	Temperature, Fahr.	Time.	Remarks.	Observers.
Putrefactive fermentation.	136°	—	—	Cohn.[1]
" "	140°	—	—	Eidam.[2]
Lower organisms.........	266°	—	Dry heat.	Paris Commission of Acad. of Sciences.
	230°	—	Moist heat.	
Vaccine.................	180°	4 hours.	—	Henry.[3]
"	172°	2 "	—	"
"	150°	2 "	—	"
"	140°	3 "	—	"
"	194°–203°	34 minutes.	—	Baxter.[4]
"	185°–194°	46 "	—	"
Most infectious diseases..	112°–140°	—	—	Erdt.[5]
Glanders................	134°	—	—	"
Hydrophobia.............	134°	—	—	"
Scarlet fever...........	204°	—	—	Henry.
Small-pox...............	230°–250°	6 hours.	Dry.	Various health officers in Gt. Britain.[6]
Anthrax (charbon).......	118½°	15 minutes.	Moist diluted.	Davaine.[7]
"	122°	10 "	" "	"
"	124°	5 "	" undiluted.	"
Virus of putrid blood.....	320°	4 "	—	Felz.[8]

VIRUS, ETC., NOT DESTROYED.

Virus, etc., experimented on.	Temperature, Fahr.	Time.	Remarks.	Observers.
Putrefactive fermentation.	122°	—	—	Eidam.
Vaccine.................	120°	3 hours.	—	Henry.
"	167°–176°	47 minutes.	—	Baxter.
Anthrax (charbon).......	212°	5 "	Dry.	Davaine.
Virus of putrid blood.....	176°	—	—	Felz.

The nature of the media in which the virus exists also has an influence upon its destruction by the agency of heat, and also by other agents.[9]

The presence of a small amount of oxygen is usually also a necessary condition for putrefactive fermentation. With regard to some kinds of putrid fermentation, it has been asserted that the presence of oxygen is not only not necessary, but acts as a preventive.[10] For some kinds, however, a

[1] Beiträge zur Biologie der Pflanzen, Heft 3, p. 30.

[2] Ibid., p. 208.

[3] Phil. Mag., X., 1831.

[4] Report of Medical Officer of the Privy Council, 1875, Lancet, 1876, Vol. I., p. 504.

[5] Veterinaer Polizei, Sorau, 1865, p. 11.

[6] Circular of Dublin Health Dept. regarding the disinfection of clothes of small-pox patients, June, 1778.

[7] Comptes rendus, Sept. 29, 1873.

[8] Ibid., LXXXIV., 953.

[9] Baxter: Loc. cit. Mecklenburgh: Berlin klin. Wochenschrift, June, 1869.

[10] Pasteur: Comptes rendus, LVI., 416 and 734.

certain amount of oxygen is necessary,[1] and it has been found by some experimenters that the addition of small amounts of agents which supply oxygen really favors the development of the organisms.[2] The investigation of this branch of the subject is, however, a matter of extreme difficulty, and much yet remains to be wrought out in this field. The matter cannot readily be settled by the use of agents which remove all oxygen rapidly, since those agents have also another action—as coagulation of albumen—which complicates the conditions they produce. Sulphurous acid and ferrous compounds (proto-salts of iron) are asserted by some to have this effect.

But, on the other hand, an excessive supply of oxygen will also disinfect. The processes of putrefaction are in fact stages in the oxidation of the constituents of the decomposing matter. If, then, we supply them with large amounts of oxygen, especially in a condensed and active form, aside from any direct action on the organisms present, the organic matter is rapidly carried through these changes to a greater or less extent according to the amounts supplied, and is converted into compounds less favorable for the development of such organisms; or, if sufficient amounts of oxygen are supplied, it is, chemically speaking, burned, and converted into absolutely harmless compounds. A number of substances used as disinfectants supply oxygen in this way. Such are ozone, or oxygen in a concentrated and active form, hydrogen peroxide, nitrous fumes, potassium permanganate, persalts of iron (ferric compounds), chlorine and bromine, or substances which can be made to supply chlorine, as chloride of lime, which, by combining with the hydrogen of water or of the organic material, sets oxygen free, etc. As was said in speaking of agents which abstract oxygen, these agents no doubt have some other action besides the simple liberation of oxygen—*e. g.*, the coagulation of the albumen of putrescible material.

Various substances also disinfect by an action which is not very perfectly understood, but which seems to have something in common with their power of coagulating albumen. That is, all these substances have the power of coagulating albumen, though their disinfecting powers are not proportional to their power to coagulate, and in the case of some at least it has been observed that a disinfecting influence is exerted by them even when they are too much diluted to coagulate albumen.[3] At any rate, the nitrogenous matter in organic substance is the chief source of nutriment to putrefactive organisms, and this explains why the decomposition of animal matter (which contains a larger proportion of nitrogenous material represented by albumen) is more dangerous than that of vegetable matter, and some action not clearly made out is exerted upon this nitro-

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[1] Meusel: Comptes rendus, LXXXI., 533. Gunning: Jour. prakt. Chem. [2], XVII., 266, etc.

[2] Calvert: Comptes rendus, LXXV., No. 19. Schroter: Vierteljahresschrift für öffentliche Gesundheit, IV., 602.

[3] Lemaire: De l'acide phénique, Paris, 1865. R. Angus Smith: Disinfectants, pp. 16, 68, 69. Schaer: Jour. prakt. Chem. [2], XII., 123.

genous matter by certain agents. The agents which effect this change are the so-called acids from coal tar—mentioned as "so-called acids" since they are, scientifically regarded, a subdivision of the alcohols known as "phenols,"—the mineral acids, and metallic salts.

Attention has been here drawn to the conditions which favor putrefaction: first, because the presence of putrefying material favors the development of zymotic diseases; and secondly, because experience has shown that whatever the nature of infection, the conditions favoring infection also favor the putrefactive processes, and, *vice versâ*, what destroys putrefaction will also destroy infection and contagion. Most of our conclusions as to the efficiency of disinfectants are drawn from experiments on putrefying material, and though the effects of disinfectants upon putrefaction may be more or less energetic than upon the virus of diseases, the difference is rather in degree than in kind.

The media surrounding the virus have a marked modifying effect upon the action of disinfectants.[1] This branch of the subject, however, has thus far not received the attention which it seems to deserve.

We will now consider separately the different agents in use for disinfection, and their applications.

Heat.

The effects of heat upon the virus of different diseases have already been given. By many the action of dry heat is considered preferable to that of moist heat. Some media in which the infection may exist appear to exert a protective action, and, to insure complete disinfection, a temperature of over 212° F. is preferred. Of course above this temperature the application of moist heat is difficult, and therefore dry heat is generally used. The heat must be kept up for a certain period in order to ensure the perfect destruction of the virus. In Great Britain dry heat is much used by the sanitary authorities for the disinfection of articles of clothing, etc., which have become infected. A chamber, constructed as if for an oven, which it really is in effect, is used;[2] the temperature is brought up to from 230° to 300° F., and the articles are subjected to the influence of these temperatures for five or six hours.

In a description of a chamber for disinfection of clothing, etc., by heat, Dr. W. H. Ransom[3] notes, as the result of his experiments, that a temperature of 250° F., kept up for seven or eight hours, will slightly alter the appearance of woollen or cotton goods, especially when dyed in delicate colors, without, however, at all injuring the strength of the fibre. Cotton and silk goods will also withstand a temperature of 295° F. for three hours without serious detriment; but if the heat is continued for five hours, the fibre suffers. Woollen goods withstood this higher temperature less perfectly than the cotton and silk.

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[1] Vide supra, note 9, page 550.

[2] Vallin: Soc. de Médecine Publique et d'Hygiène Professionelle, June, 1877.

[3] Pharmaceutical Journ. and Trans., Vol. XXXIX., p. 206, Sept., 1873.

Before turning our attention to gaseous disinfectants, a few words on what is known as *aërial disinfection* are necessary. If by aërial disinfection we mean the removal of infection from the atmosphere of a space, whether closed or open, while at the same time human beings can breathe it without discomfort or detriment, that state of affairs has not yet been attained. In other words, if we render an atmosphere destructive to the life of germs, or whatever the virus of infection may be, it is also rendered irrespirable for human beings, and there is no true aërial disinfection.[1] To effect disinfection with sulphurous acid or chlorine, at least one per cent. of these agents should be present in the air, which amount is far beyond what can be endured by a person in health; and if an invalid were in a room where such considerable quantities of those substances were present in the air, the effects would be still more unbearable. When carbolic acid was first introduced it was hoped that it would fulfil the requirements of an aërial disinfectant, but it has been found that, to disinfect under any circumstances, more carbolic acid than sulphurous acid or chlorine is necessary, and it is moreover condensable. Numerous experiments and experiences have shown that carbolic acid fails utterly in this regard,[2] and that the assertions of sanguine experimenters with the new disinfectant, that so long as the odor of carbolic acid is perceptible, there is no danger of infection, have been productive of much mischief by creating a false sense of security in many cases.

The most that we can hope to do in a room where infection is known or suspected to be, is to use agents which will render the air, so far as may be consistent with our own comfort, unfavorable to the growth or development of infection, so long as the room may be occupied; or, what is better, to take measures to change the air of the room as frequently as possible, in order to diminish the danger of infection by dilution; and, when the room can be vacated, to saturate the atmosphere in it with some disinfecting gas—not in order to purify the air in it and render it safe, but in order to kill out the infection which may have existed there, and which has attached itself to the walls, carpets, furniture, hangings, etc.

Sulphurous Acid.

This acid (or, more correctly speaking, *oxide*) is the substance which affords the well-known pungent and suffocating smell observed when a sulphur match is burned. It is a gas about two and a quarter times as heavy as air, and so far as its use in disinfection is concerned, may be considered as uncondensable. It is soluble to the extent of six or seven per cent. by weight in water, but the solution has a tendency to lose in strength, and is therefore unsatisfactory for practical purposes. The gas is usually made, when wanted, by burning sulphur.

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[1] Wanklyn: Pharm. Journ. and Trans., 1873, Vol. XXXIX., p. 205. Wiederholt, Deutsche Industrie-Zeitung, 1870, p. 442.

[2] Letheby: Right Use of Disinfectants, Soc. of Med. Officers of Health, Oct. 18, 1873; Am. Chem., IV., 381.

Sulphurous acid is largely used for bleaching purposes and in other industrial processes. It is also one of the oldest disinfectants known, and still holds a place in the foremost rank of the substances so used.[1] Its action upon putrefying material is due mainly to the coagulation which it causes of the albuminous principles, thereby depriving the organisms of the pabulum which they require; it also, no doubt, exerts a destructive influence upon the virus of infection. It destroys sulphuretted hydrogen and neutralizes ammonia. It cannot, however, be used with effect in places where human beings are exposed to its influence, on account of its irrespirable properties. So small an amount as one part in ten thousand of air will produce discomfort, and twice that proportion is unendurable.

Sulphurous acid and chlorine mutually neutralize one another, and cannot therefore be used together.

In disinfecting a room, from one and a half to two ounces of flowers of sulphur or crushed roll sulphur should be used for every hundred cubic feet of space. The sulphur should be supported on an earthen or tin plate placed over a layer of sand or a vessel of water, in order to avoid the danger of fire. It may be ignited by placing upon it a live coal, and the room must then be closed and left for five or six hours. If the air of the room is not damp, the colors of the hangings, etc., unless delicate, will not suffer seriously.

Carbon disulphide is sometimes burned with the object of obtaining sulphurous acid for disinfecting purposes.[2] There are, however, many objections to its use. It is more expensive, and where a pound of sulphur will suffice, nineteen or twenty ounces of the disulphide is required. The chief objection to it, however, is its extreme volatility, as well as its combustibility, which renders it extremely dangerous to keep or handle.

Sulphites, or combinations of sulphurous acid with bases, such as sodium, etc., may be used for the generation of sulphurous acid by the addition of a stronger acid, such as sulphuric or muriatic acid. This mode of obtaining sulphurous acid is, however, seldom used, on account of the expense. On the other hand, sodium sulphite is largely used as an antiseptic, often in conjunction with carbolic acid.[3]

The effects of sulphurous acid in fumigation are, of course, only temporary, and if a room which has been fumigated is again exposed to an infectious atmosphere, it may in a short time become as dangerous as before, and the fumigation must be repeated.

Putrefying liquid or semi-liquid material, when impregnated with sulphurous acid gas, is first deprived of any capacity to continue in a state of putridity, or to give out any odorous gases. If, however, the action has not been sufficient to completely kill all germs of infection and

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[1] Baierlacher: Medicinisches Centralblatt, 1876, p. 908. Fischer, Verwerthung der Städtischen- und Industrie-Abfallstoffe, p. 68. Dingl. Polyt. Journ., CCXIX., 550, and others.

[2] Keates: Chemical News, XXXIV., 245.

[3] MacDougall's Disinfecting Powder, Chem. News, 1862, p. 271.

render the mass acid, the putrid fermentation may again set in, and then, by decomposition of the sulphurous acid, more sulphuretted hydrogen than before will be evolved.

Chlorine, Bromine, and Iodine.

Chlorine is a pale, yellowish green gas at ordinary temperatures, about two and a half times as heavy as air. It is extremely irritating to the lungs, even when present in not very large quantities. By combining with the hydrogen of water, or of some organic substance with which it may come in contact, it sets oxygen free, and thus is classed as a powerful oxidizing agent. It decomposes ammonia and sulphuretted hydrogen, and in general kindred compounds arising from the putrid fermentation of organic matter. It may be used for aërial disinfection, like sulphurous acid, but, as is also the case with this latter reagent, the destruction of all infection can only be insured by rendering an apartment temporarily uninhabitable.

Chlorine may be generated in various ways. The principal methods are :

1. By the action of muriatic (hydrochloric) acid (3 parts by weight) upon black oxide of manganese (2 parts by weight).

2. By mixing together equal parts of black oxide of manganese and common salt, and pouring upon them about two parts by weight of oil of vitriol (sulphuric acid).

3. By the action of muriatic or sulphuric acid upon chloride of lime, nearly weight for weight being required.

4. By the addition of a strong acid, such as muriatic or sulphuric, to potassium chlorate. This latter method affords not only chlorine, but considerable amounts of oxygen and compounds of the two elements.

5. The action of muriatic acid upon red oxide of lead has also been used to develop this gas.

In disinfecting an apartment, for 100 cubic feet of space it would be necessary to use about half or three-quarters of a pound of black oxide of manganese, and from three-quarters of a pound to a pound of strong commercial muriatic acid; or the same amount of the manganese oxide may be used with an equal weight of salt and from one to one and a half pounds of oil of vitriol; or between one and two pounds of chloride of lime with nearly an equal weight of acid, diluted with about twice its bulk of water. The substances should be mixed in a large earthen dish of sufficient size to allow for frothing up.[1] The evolution of the gas is so rapid that it is difficult to make the mixture complete before the person who manipulates it is obliged to abandon it on account of the fumes. The colors of hangings, etc., even when dry, are more seriously affected by chlorine than by sulphurous acid gas.

[1] The Commission of the Paris Academy of Sciences (Comptes Rendus, LXXII., 242) recommends enclosing the chloride of lime in a linen or canvas bag, and immersing it in about the same weight of acid diluted with three times its bulk of water. This plan may be pursued with advantage.

Chloride of lime (bleaching-powder) is made by saturating slacked lime with chlorine, and contains ordinarily, when of fair quality, some thirty per cent. or more of chlorine (called "available") which may be set free by the application of an acid. The combination in which the chlorine exists in it is what is known chemically as calcium hypochlorite, which, however, readily affords chlorine with acid or acid salts. Alum or chloride of zinc is sometimes used for this purpose. About one and a half pounds of powdered alum or two pints of chloride of zinc solution should be used to the pound of chloride of lime. The latter, unless well protected from the external air, loses in strength, especially in the presence of dampness.

Labarraque's solution of chloride of soda is a compound similar to chloride of lime, having, instead of the lime, soda as the base. *Javelle water* is the corresponding potash compound. These compounds may be used in the same way as the chloride of lime, but as the amount of available chlorine which they contain is usually much smaller (between one and three per cent.), the amounts to be used to produce the same effects are much larger.

Chloride of lime is often used without any addition of acid in disinfecting street gutters, sewers, privy vaults, etc. In a solution of half a pound or more to a gallon of water (which, by the way, will not give a clear solution), it is used for washing floors, disinfecting clothing, etc. The action is similar to that of chlorine, though the presence of the lime, if no acid is added, gives some of the effects which will be described under Lime and Alkalies.

Bromine.

Bromine, under ordinary conditions, is a dark liquid, which vaporizes at all temperatures, is very soluble in water, from which solution, however, it readily escapes, and has a strong, stifling odor. In its properties as a disinfectant it resembles chlorine, though, for the same amounts by weight, it is only about one-third as efficient as chlorine. On account of its liquid form and its ready solubility in water, it is in some respects more convenient for disinfecting purposes. Its expensiveness, however, is the probable reason why it has been but little used. If employed, it should be used in the same way as chlorine, but it must be remembered that about two and one-half times as much bromine as chlorine is necessary.

Iodine.

This is similar in properties to the two preceding, but on account of its expensiveness has been used still less than either of the others. At ordinary temperatures iodine is a steel-colored solid which slowly gives off violet vapors of a pungent odor. Not having so disagreeable an odor as bromine, it might be used to improve the air of apartments where such purification seems desirable. It has, however, received so limited an ap-

plication as a disinfectant, that but little can be said of its powers or effects in that regard.

In terminating a notice of the use of these gases in disinfection it may be remarked that the inhalation of alcohol vapors will afford relief to any one who may accidentally become choked with the fumes.

Oxygen.

The liberal use of fresh air, when danger from infection is to be apprehended, cannot be too urgently commended. We cannot, however, be certain that the oxygen of the air will destroy the virus of infection as rapidly as may be desired, and many incline to the belief that the chief advantage of a frequent renewal of the air in our houses is to be ascribed to the dilution of the infection rather than to its destruction.[1] Nevertheless, in whatever way the action may take place, the advantages of plentiful ventilation in protecting ourselves against disease are too great to be neglected.

The oxygen of the air may be pressed into service as a disinfectant by the use of porous materials, such as charcoal, or by the use of powders even of inert substances. This is owing to the property, which substances in that form have, of condensing upon their surfaces considerable amounts of air, and at the same time the noxious gases or germs which may be in it, and, by thus bringing the two into intimate contact, an active oxidation is effected.[2] Still the use of powders in this manner, though of advantage, naturally does not do all that could be desired in the line of disinfection by the use of oxygen in our homes, though the well-known disinfecting action of dried earth and of charcoal powder shows how much can be accomplished by this mode of action of porous or pulverulent substances.

Thus far the direct applications of oxygen to disinfection have been more limited than we could wish, chiefly on account of the expense and difficulty of the methods as at present known and practised. We may, however, hope in this practical age to arrive at more perfect and satisfactory methods of making an effective and general use of this agent so valuable in disinfecting.

Ozone is a concentrated and active form of oxygen, which has been to some extent used as a disinfectant.[3] As yet, however, the methods of obtaining it in such a state that it can be advantageously applied are not altogether satisfactory. It may be produced by the electric discharge, by the exposure of moistened phosphorus to the action of the air, by passing a current of air through a Bunsen gas flame,[4] and in other ways. It exists in small quantities in the air, especially after thunder-storms, though

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[1] Endemann: Report of New York Health Department for 1874 and 1875, p. 254.

[2] Erismann: Z'tschrift für Biologie, Vol. II., p. 207. Hofmann: Reports by the Juries, London, 1863, p. 104.

[3] Thénard: Comptes rendus, LXXXII., 157. De Carvalho: Dingl. Polyt. Journ., CCXX., 285.

[4] Loew: Zeitschr. f. Chem. [2], VI., 65, 269.

the amount is much less in the neighborhood of cities and towns, and it often is entirely wanting in such localities. The preparation of ozone by moistened phosphorus has been used in the household, the heads of common matches being used for the phosphorus which they contain. The action of sulphuric or oxalic acid upon potassium permanganate has been recommended as a source of ozone, but its production by use of the latter acid has been questioned, undoubtedly with reason. It has been asserted by many experimenters that ozone is also produced by the slow oxidation of turpentine and of many of the odoriferous essential oils which have the same chemical constitution as turpentine,[1] and that this explains the use, especially in the East, of essences and odors as deodorizers and disinfectants; and hence such substances have been recommended for these purposes.[2] Recently some "toilet vinegars" have been prepared which contain essential oils, and the efficiency of which is believed to depend upon the property possessed by these oils of producing ozone. The effects obtained in this way, however, are not of any practical importance.

Hydrogen peroxide, which may be regarded as a combination of oxygen and water, on account of the facility with which it will give up oxygen, is probably the best disinfectant that we could wish for. Unfortunately, it is scarcely known outside of the laboratory, and, as usually prepared, loses in strength by keeping. The solutions sold by druggists under this name, in some cases at least, have proved to be—not peroxide of hydrogen — but hypochlorous acid, the combination of chlorine and oxygen, which, when combined with calcium, forms the chief constituent of bleaching-powder.

Nitric acid (aqua fortis) and the lower oxides of nitrogen, known collectively as "*nitrous fumes,*" give up oxygen readily to organic substances, and have therefore been much used and recommended in disinfection. Nitric acid itself is so slightly volatile at ordinary temperatures, that it cannot well be used for aërial disinfection. The fumes arising from a partial decomposition of the nitric acid, however, can be used in this way. The fumes are of a strong orange or reddish color when evolved in the air, and are somewhat irritating to the lungs and other tender portions of the body. They are, however, extremely dangerous, since a person may be exposed to them in a certain degree of dilution for a short time without experiencing a very great inconvenience, and then, a few hours afterward, may die from the effects of the gases upon the lungs. Since they are so treacherous, they are not so desirable for use in disinfection. Moreover, they exert an energetic action upon the colors and fibres of stuffs, and upon metals, and cannot therefore be used in many cases.

Nitrous fumes may be obtained by diluting the commercial nitric acid with three or four times its bulk of water, and adding to the dilution iron

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[1] Experiments by Kingzett (Jour. Lond. Chem. Soc. [2], XII., 511; XIII., 210; and Chemical News, XXXII., 138) go to show that no ozone is formed, but substances giving hydrogen peroxide by contact with water.

[2] Dr. John Day: London Chemist and Druggist, Nov. 15, 1873.

scraps or filings, or copper or zinc turnings. About twice as much of the commercial acid as metal should be used. The operation should be performed in a large vessel, as in the course of a short time the mass froths up, and the action is extremely energetic, considerable heat being at the same time generated. When the action is over, the solution remaining is also useful as a disinfectant, though for such a use the free acid which may remain should be neutralized by throwing in the metal until a portion remains undissolved.

Acids from Coal Tar.

It has already been remarked that these compounds are not true acids, chemically speaking, though the term acid has been so universally applied to them in a commercial way, that those unacquainted with chemistry usually suppose them to be really acids. The principal compounds of this nature used in disinfection are, carbolic and cresylic acids (phenol and cresol). Thymol, a compound similar in constitution, also occurs in coal-tar, but in small quantities, and is usually obtained from oil of thyme.[1] In this connection, creasote from wood-tar may also be mentioned.

Carbolic acid[2] and *thymol*, when pure and free from water, are transparent crystalline solids; the others are liquids. All have an aromatic odor, which—except in the case of thymol—recalls that of wood-smoke. Pure carbolic acid dissolves in about twenty parts of water; the others are less soluble in that menstruum. The use of an equal bulk of acetic acid or strong vinegar materially increases their solubility.

The impure forms of these substances are more common, and have usually a brown or black color, and also may have the disagreeable odor of sulphur compounds, due to imperfect purification. The material sold as impure coal-tar creasote may contain only 20 or 30 per cent. of carbolic and cresylic acids.

Wood creasote is not so thoroughly understood in its chemical relations as the other compounds here mentioned, and the effective value of its preparations cannot be so accurately laid down.

The disinfectant and antiseptic properties of carbolic and cresylic acids have been much discussed, and their use for both purposes has been highly recommended by many. Notwithstanding various statements with regard to their efficiency as aërial disinfectants, it has finally been proved that their value in that regard is too small to be of practical importance. Their action upon putrefying material or upon infection has been described by Dr. Angus Smith[3] as arresting the motion incident to decay. Pettenkofer[4] asserts that their action is exerted by their presence, and

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[1] Paquet: Bull. gén. de thérapeut., 1869, No. 25, p. 205. Husemann: Chem. Centralblatt, 1875, 822. Peschechonow: Pharm. Zeitschrift für Russland, XII., 609. Lewin: Med. Centr'blatt, 1875, p. 324.

[2] Runge: Pogg. Anal., XXXI., p. 70, 1834.

[3] Disinfectants, p. 62.

[4] Allgemein. Zeitung, Feb., 1866.

their influence ceases as soon as they are removed—in other words, that they do not induce a permanent change in the putrefiable material, but simply suspend the action of the processes of putrefaction so long as they are present. From this it would be inferred that their use is chiefly as antiseptics, and not as disinfectants; and this is the light in which they are now regarded by many.[1] One per cent. or more of the coal-tar acids is necessary to arrest putrefaction, or render inert the virus of infection,[2] while far smaller proportions suffice to exert an antiseptic action. These acids absorb to some extent the sulphuretted hydrogen and ammonia from putrid fermentation, but scarcely to a sufficient extent to merit the name of deodorizers, unless we should consider as deodorizers those compounds which overpower, by their own peculiar odor, the disagreeable smells we may encounter. One method of using the pure acid as a deodorant consists in mixing it with an equal weight of camphor. The two unite to form a liquid compound, the nature of which has not yet been investigated, and by this means the odor of the carbolic acid is much modified.[3] The mixture has been proposed for internal use in cases of enteric fever and similar diseases.

Carbolic acid is best used in solution in water, in the proportion of one part in one hundred, or one part in forty for washing places and articles which may contain the virus of infection or contagion. It is also used very efficiently in conjunction with salts of iron or zinc, or with sulphite of soda, as well as mixed with substances in powder, such as slaked lime, etc.

The pure acid dissolves in water with tolerable facility on briskly agitating the mixture for a short time. If the crude acid is used, about twice as much should be taken, and the agitation with water must be more prolonged and vigorous to insure solution. Some oil always remains undissolved from the crude acid, which, unless well agitated, may hold some carbolic acid.

If we wish to employ a mixture of the acid with iron salts, about four pounds of protosulphate of iron (ferrous sulphate), or about three pints of what is known as "strong solution of perchloride of iron," should be dissolved in a gallon of water, and the equivalent of from two to three ounces of pure carbolic acid should be well mixed with it.[4] A solution of zinc chloride (Burnett's fluid)[5] may be used in the same proportion as the perchloride of iron. This gives, it is true, strong solutions; but, as they are generally used on liquid matter, such as the contents of cesspools, drains, etc., they become sufficiently diluted when thus employed. If used on solid sub-

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[1] Notice sur le nettoiement de la voie publique, Paris, Préfet de la Seine, 1876.

[2] Plugge: Pflüger's Archiv f. Phys., V., 538. Dougall: Glasgow Med. Jour., Nov., 1872. Baxter: Loc. cit. Rosenbach: Untersuchungen über den Einfluss der Carbolsäure gegen das Zustandekommen der Pyämischen und putriden Infektion bei Thieren, Göttingen, 1872. Davaine: Comptes rendus, Oct. 13, 1873.

[3] Report of New York Health Dep't, 1869, p. 576.

[4] Metropolitan Disinfectant. Report of N. Y. Board of Health, 1870, p. 77.

[5] U. S. Dispensatory, 13th Ed., p. 1275.

stances, the solutions mentioned may be diluted with five or six times their bulk of water.

Carbolic acid powders have been largely manufactured and sold as disinfectants, but faith in their efficacy is not so great now as formerly. Nevertheless, they have some value for mild disinfecting purposes, though it is better for one to make them for himself rather than trust to what he may obtain under that name in the market, since their quality is very uncertain, and many contain scarcely more carbolic acid than suffices to give them its distinctive odor.[1] In making them we may use any absorbent material, such as sawdust, clay, quick-lime, etc. The latter is in many cases advantageous. About 5 parts of the pure acid, or 10 parts of the crude, should be thoroughly mixed with 100 parts of the dry powder.[2] When sprinkled about, the effect of the powder, as explained under "*Oxygen*," aids the action of the carbolic acid. It may produce good effects when freely applied on floors and such surfaces as are more or less moist with liquids that may be suspected of containing infection.

Carbolic acid in concentrated form, when in contact with the skin, destroys the external coats, leaving a white spot where it has touched it. Taken internally, unless much diluted, it is very poisonous. The antidote generally used is olive oil.

Acids.

Benzoic, *picric*, *acetic acids* are the principal organic acids which are of use in disinfection. They are better, however, as antiseptics than as disinfectants. Acetic acid is the only one which can be used for aërial disinfection, a use to which it was frequently put in the Middle Ages. It cannot be relied upon in serious cases, and at present is scarcely used.

The mineral acids, *hydrochloric* (muriatic), *nitric*, and *sulphuric*, have strong disinfecting powers. Hydrochloric acid is the only one which has been used as an aërial disinfectant. The destructive influence which it exerts upon substances of whatever kind, and its irritating properties, have prevented it from being used very extensively. The same destructive influences characterize the other acids and are strong objections to their use, since, even if the place to be disinfected is only a cesspool, the acids, if added in sufficient proportion to disinfect, will produce an injurious effect on the cement of the masonry. They will also set free sulphuretted hydrogen from its combinations, and at first increase the bad odor. The acids act by coagulating albumen and by neutralizing ammonia and other compounds of that type which may be dangerous.

Metallic Salts.

The *metallic salts* stand first as disinfectants for liquids containing any matter of a dangerous character. They arrest putrefaction and destroy

[1] Waller: Report of N. Y. Health Department, 1873, pp. 467 et seq.

[2] E. de Haen: Deutsche Industrie-Zeitung, 1874, p. 312.

infectious matter by coagulating albuminous principles, and by absorbing the nitrogenous and sulphurous compounds of which ammonia and sulphuretted hydrogen have been taken as types; they probably also exert some other effects not always clearly defined. They are all more or less poisonous, and some of the most efficient are too poisonous for general use, as for example the arsenic and mercury compounds. Since they are not volatile at ordinary temperatures, they have little or no value as aërial disinfectants. The best disinfectants among them are the *zinc* and *iron salts*. They usually are to be obtained as sulphates or chlorides. Of these the former are the most common, while the latter are preferable, since after a time the sulphur in the sulphates will sometimes escape as sulphuretted hydrogen, with its characteristic unpleasant odor.[1]

Manganese and *lead salts* are also good as disinfectants.

Iron Salts.

These are of two kinds, known usually as the protosalts and the persalts—or, scientifically, as ferrous and ferric salts respectively. The best known ferrous salt (mentioned first because the most universally used) is the *ferrous sulphate*, commercially known as *copperas*, *green vitriol*, or *protosulphate of iron*. For efficiency, combined with cheapness, this compound is the best of its class. Though to some extent poisonous, when taken into the stomach, it is not so much so as many other disinfectants in use, and its peculiarly unpleasant taste is usually sufficient to warn one of the danger before enough has been swallowed to cause serious results. The solution dropped upon cloths or other absorbent material, if not quickly removed, gives them the well-known iron-rust stain, and it cannot therefore be used in washing or disinfecting white goods, if it is desired to keep them white. If strong, the solution may destroy or materially injure the fibre. On heating the salt for some time with free access of air (roasting), it is partially converted into the persalt (ferric sulphate). The mixture thus obtained is still better as a disinfectant.[2] To get a tolerably clear solution of the salt after roasting, it is necessary to add about an ounce of oil of vitriol to the pound of crystals used.

The best known and most common persalt of iron is the *chloride* (*ferric chloride*), known commercially or officinally as *sesquichloride* or *perchloride* of *iron*. The nitrate and sulphate are also used in medicine. For disinfecting purposes a solution may be made by dissolving bits of iron (nails, etc.) in muriatic (hydrochloric) acid, with the addition of about a fluid ounce of commercial nitric acid to each ounce of iron used. The muriatic acid should be diluted with an equal bulk of water, and the liquid should be allowed to act upon the iron for some time, the metal being in excess, in order to avoid the presence of much free acid. Or a solution of iron nitrate may be prepared by allowing nitric acid to take up all the iron it

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[1] Béchamp: Dingl. Polyt. Journ., 191, 336. Cohn: Beiträge zur Biologie der Pflanzen, III., p. 156.

[2] Kletzinsky: Am. Chem., IV., 131.

will dissolve. (See "*Nitrous fumes*.") The gases arising in either case are to be avoided, since it is dangerous to breathe them. The nitrate is the best as a disinfectant. The chloride is kept by druggists as "strong solution of perchloride of iron."[1]

These salts of iron act by absorbing or destroying sulphuretted hydrogen and similar compounds, and by absorbing ammonia and nitrogenous compounds of that nature. They also oxidize organic material with which they may come in contact. The persalts naturally are the most efficient in this respect, though the roasting of the protosalts, or their exposure to air even without roasting, will cause them to absorb oxygen, which they again give up under the circumstances above mentioned. Like most other metallic salts, they also coagulate albuminous matter, thus depriving the organisms of putrid fermentation of the pabulum necessary for their existence. The iron salts are used in all cases where we have to deal with foul liquids, such as the contents of drains, sewers, etc.[2]

Zinc Salts.

Zinc sulphate, known as white vitriol, and the *chloride* (Burnett's[3] solution) are the compounds usually employed and most available. Zinc salts form with albuminous principles extremely insoluble compounds, and at the same time absorb the gases from putrefying material. On this account they are probably the best disinfectants of this class which we have. Being colorless they can be used in many cases—as in the disinfection of bed-linen, etc.[4]—where salts which impart a color (*e. g.*, those of iron) cannot be used. If the solution be very strong, there may be some danger of injury to the fibre of the goods; but with solutions such as are usually employed, the effect is practically inappreciable. Both the sulphate and chloride are poisonous, the latter being the more dangerous. The effect, however, is usually so strongly emetic, when the salt is swallowed, that the poison is expelled from the stomach soon after swallowing it.

Of the two salts mentioned the sulphate is the cheaper, but the chloride is rather the better disinfectant. The solution known as Burnett's should contain a little less than half its weight of the chloride. Large amounts of zinc salts are obtained from the refuse products of certain industries, from treating tin scraps, for example, and from establishments where electric batteries are used. Such solutions naturally contain salts of other metals, which, though objectionable for many purposes to which the solutions might be applied, are not objectionable, and may indeed be of advantage, when used for disinfection. One point should be mentioned in this connection, viz., that these solutions often contain free acids, which should be neutralized by allowing them to stand for some time over bits of zinc. Zinc chloride, containing more or less free acid, has been

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[1] U. S. Dispensatory, 13th Ed., p. 1251.

[2] Hofmann and Frankland: Cosmos, XV., 283; Polyt. Centr'blatt, 1860, p. 64.

[3] London Med. Times and Gaz., Oct., 1853, p. 341.

[4] Am. Chem., IV., 66.

proposed for use in conjunction with chloride of lime in disinfection. The chlorine is thus set free to purify the atmosphere, while the zinc remains in the solution to render inert the organisms which generated the noxious gases.

Manganese Salts.

The protosalts of *manganese* are not so much used in the United States as in Europe, since they are not so plentiful or cheap here. The sulphate is the most common form, and the one from which almost all of the officinal preparations of manganese are made. The so-called manganese lye,[1] a by-product from the manufacture of chlorine by the action of muriatic acid upon black oxide of manganese (see "*Chlorine*"), contains the elements of an excellent disinfectant, but at the same time often contains too much free acid to admit of its being used except where the free acid will not produce undesirable effects—*e. g.*, injury to the cement of vaults, etc.

Manganese protosalts are, to a very slight extent, poisonous; the effects are usually purgative.

Their action as disinfectants is very similar to that of zinc, to which they are somewhat inferior. They may be used for the same purposes, and in the same way, though for clothing, etc., the zinc is much to be preferred, since the manganese compound, especially after contact with alkalies, soap, etc., will cause discoloration.

Potassium permanganate has been much used in disinfection for oxidizing purposes. The solution, known as Condy's fluid,[2] has a strong purplish color, which, in the presence of organic matter and acid, disappears entirely. If, however, no acid is present, brown flocks separate. The solution is odorless, and has a sweetish taste. It is much used for cleansing vessels that are employed about a sick-room, or wherever there is any danger of infection. It is also used to purify water for drinking purposes. An amount sufficient to color the water of a pinkish tinge is added, and the water is allowed to stand for a couple of hours. If the water loses the pinkish color, more must be added until the color will stand for about two hours. Some authorities claim that this is insufficient to purify the water, and in some cases it may be preferable to make sure by boiling the water after this treatment. In small amounts it is not dangerous to take into the stomach, though large quantities of this salt are apt to produce bad effects. In contact with fibres, etc., it imparts a brown stain, very difficult to remove, and hence cannot be used in washing clothing, etc., the color of which it is desirable to preserve. A solution of one part of the salt in about ten of water, mixed with an equal bulk of oil of vitriol (sulphuric acid), affords ozone. The strong color imparted by this salt to water, when dissolved in it, is so great that one

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[1] Junghaus: Dingl. Polyt. Jour., CXCIX., I., Am. Chem., II., 92.

[2] Condy: Propriétés désinfectantes des permanganates alcalins, Paris, 1867. Cf. Monit. scientifique, 1865, 125.

may readily be deceived as to its strength; and solutions containing a very small amount—too small to be of any service, but yet sufficient to give a strong color to the fluid—have been sold by druggists for disinfecting purposes. It is always better to purchase the salt in crystals, and dissolve it for use when wanted.[1] From one to one and a half ounces of the salt in a gallon of water is a suitable strength for most purposes.[2]

Alumina Salts.

Common potash alum, which is a double sulphate of alumina and potassium, is the best-known form of soluble alumina salt. Within a few years a chloride of aluminum, under the name of "chloralum," has been offered in the market as a disinfectant.[3] The absence of poisonous properties in alumina salts, as compared with most other disinfectants, has been urged as a desirable quality in these preparations. Their disinfecting powers are, however, not sufficient to make them the valuable disinfectants they are asserted to be.[4] They render efficient service as antiseptics. Their action is similar to, though much weaker than, that of the zinc or iron compounds. A mixture of one pound of powdered alum with one pound and a half of chloride of lime affords a good means of slowly setting free the chlorine from the chloride of lime, in cases where the rapid liberation of the chlorine is not desirable.

Alumina salts may be used either for purifying drinking-water or for disinfecting sewage.[5] For purifying drinking-water, about ten grains of alum should be added to the gallon, and, after being well mixed in, the addition of about half as much of carbonate of soda will precipitate the alumina, which then carries the impurities down with it. In the case of sewage, a larger proportion of the alum must be used, and milk of lime may be substituted for the carbonate of soda.

Copper salts are excellent as disinfectants. They have, however, been but little used on account of their expense. The sulphate (blue vitriol) is the best-known form. The waste liquors from telegraphic batteries usually contain small amounts of copper compounds which aid their action.

Lead salts have been used to a certain extent,[6] although their value is

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[1] The writer once had occasion to examine a solution of this salt, which contained it in the proportion of less than one-tenth of an ounce in the gallon. The solution had a strong color, and was sold for fifty cents the *half-pint*. Half a dollar is a high price for *an ounce* of permanganate of potash.

[2] Demarquay: Comptes rendus, LVI., 852.

[3] Fleck: Industrie-Blätter. IX., 25; Deutsche Industrie-Zeitung, 1871, p. 476.

[4] Endemann: Report N. Y. Health Dept., 1871, p. 117. Letheby: Am. Chem., IV., 381. Fischer: Dingl. Polyt. Jour., CCX., 132.

[5] Polyt. Centralblatt, 1869, 416; Chemical News, XXXIV., 197. Durand Claye: Deutsche Ind.-Zeitung, 1869, 486.

[6] Goolden: Lancet, Dec. 11, 1875.

not so great as that of the zinc salts. Their cost and their poisonous qualities are much against them.

Mercury and *arsenic compounds* have already been mentioned as powerful disinfectants, but they are too poisonous for general use.

As a general rule, it is better to purchase of reputable druggists the crystallized salts desired for disinfecting purposes. It is then easy to make solutions of the strength desired, and it usually is much cheaper, since most of the preparations put up and sold under various high-sounding names as disinfectants, while they contain compounds of value in disinfection, contain really far less of those compounds than could be purchased, in the solid form, for the same money.

Lime and Alkalies, and their Compounds.

Caustic lime (quick-lime or slaked), *potash*, and *soda* have but small disinfecting powers unless used in concentrated forms and in considerable quantities. On account of their solvent and cleansing action, however, they are advantageously applied as detergents. Rooms, outhouses, etc., after being disinfected with sulphurous acid or chlorine gas, should be freshly whitewashed with lime, and the floors should then be scrubbed with a hot solution of soda or potash. Quick-lime freshly broken may be sprinkled about when it is desirable to absorb moisture or carbonic acid gas, while soda or potash may be used in solutions in which infected clothing is to be cleansed. If used in too great strength, they will dissolve and disintegrate woollen goods. Cottons are much less affected. A solution in the proportion of half an ounce of the solid potash or soda to the gallon of water is sufficiently strong.[1] Lime carbonate is practically of no use; hence the recommendation to use *freshly* broken quick-lime. The carbonates of potash and soda are much less efficient than the caustic alkalies, but may be substituted for them in default of the caustic form. In using these alkalies on clothing, care should be taken that zinc salts be not employed at the same time. If, however, it be thought desirable to use the latter, a thorough rinsing should intervene, since these alkalies precipitate the zinc from its combinations.

The chlorides of these bases, especially of calcium[2] and sodium, have been

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[1] Watt's Dictionary of Chemistry, V., p. 1047.

[2] The distinction between the calcium and sodium chlorides and the so-called chlorides of lime and soda, is an important one, which should not be disregarded. The calcium and sodium chlorides contain chlorine, it is true, but not in such a state that it can be readily set free in the form of gas to exert its powers. Those names are the true technical names for those compounds. The chlorides of lime and soda are, on the other hand, commercial names for compounds known technically as calcium and sodium hypochlorites respectively, and from these chlorine is readily freed by the addition of an acid or acid salt. But, aside from any addition, the properties of the two classes with respect to their disinfecting action, and indeed in other respects, are very different, and care should be taken that the similarity of names do not lead to confusion of two very different classes of substances.

recommended for disinfecting purposes,[1] but their powers in this respect are not very great. Their cheapness, however, especially in the neighborhood of alkali works may sometimes render them the best available disinfectants.

Sulphate of lime (calcium sulphate), on account of its power of absorbing ammonia, is of some value for disinfecting excreta or other substances, which possibly may prove dangerous on account of the nitrogenous organic matter which they may contain. Being only slightly soluble in water, and not having the power of fixing large quantities of ammonia, it is used almost exclusively for admixture with manure or other fertilizing matters[2] —a purpose which is usually defeated when the stronger disinfectants are used. Magnesium compounds, the capacity of which for absorbing ammonia is much greater, have been used in a similar way.[3]

The Different Disinfectants, the Conditions under which each may advantageously be employed, and the Best Methods of using them.—A Brief Recapitulation for Ready Reference.

The following suggestions may be useful for those charged with the duty of disinfection:—*For streets and public places.*—All material liable to decompose should be removed, and if no other disposition can be made of them, they should be sprinkled with lime and buried. Sprinkle chloride of lime about and throw roasted iron sulphate in the gutters, where it will slowly dissolve. In damp and illy ventilated places freshly broken stone-lime or calx powder—a mixture of quick-lime and charcoal[4]—may be spread about.

For cesspools and vaults.—About a pint of the solution of carbolic acid and iron or zinc salts, made as described under "*Carbolic Acid*," may be added to each cubic foot of contents. Another method which will be found efficacious consists in suspending a bag containing roasted iron sulphate in the upper portion of the liquid, and allowing solution to take place slowly. This method requires that about six ounces of the iron salt should be allowed for every cubic foot of contents of the vault.

The air arising from cesspools, drains, sewers, etc., may be disinfected by the use of charcoal filters, wherever access to the external air is permitted. The simplest form of such filter would consist of a double-wire gauze, the two sheets of which are separated by a space filled with powdered charcoal. This principle has been for some time successfully used in some parts of London. *Stagnant pools*, if they cannot be immediately drained, may be treated, first, with a cold saturated solution of alum, and then with milk of lime. *Sinks and water-closets.*—Kitchen sinks may often be clogged, partially by the hardening of grease in the waste-pipes. In such cases pour down a boiling-hot and strong lye of potash or soda, and rinse with water before pour-

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[1] G. C. Stanford: Archiv der Pharmacie, CCIII., 24.

[2] Vohl: Dingl. Polyt. Journ., CXIV., 65. Jacquot: Ibid., CIII., 152.

[3] Dingl. Polyt. Journ., CCXIX., 182. Blanchard and Chateau: Comptes rendus, LXII., 446. Suvern: Industrie-Blätter, 1868, p. 62.

[4] Applied on a large scale by Müller and Schür (Dingl. Polyt. Journ., CLXXVIII., 78). The proportions used were from twenty to twenty-five parts of quick-lime to two parts of dry charcoal powder. A larger proportion of charcoal might be advantageously employed in some cases.

ing in the disinfectant. Pour down two or three times a day a pint of one of the following solutions:

Four pounds of iron sulphate in one gallon of water. If the iron salt has been roasted, add about one ounce of oil of vitriol (sulphuric acid) to the gallon.

Two pounds of zinc sulphate in one gallon of water.

One pint of zinc chloride solution (Burnett's solution) in the gallon.

One pint of "strong solution of perchloride of iron" in the gallon.

About two fluid ounces of carbolic acid may be added with advantage to each gallon of either of the above solutions. Manganese sulphate may be used in place of the zinc sulphate.

Outhouses, cellars, stables, etc.—Freshly broken quick-lime sprinkled about will absorb moisture if these places are damp, and on that account liable to generate or retain infectious germs.

Cleanse with water containing carbolic acid in the proportion of 2 or 2½ ounces in 3 gallons. Whitewashing with about the same proportion of carbolic acid in the gallon of whitewash, and sprinkling chloride of lime about, will be found advantageous.

Apartments.—Saucers containing calx powder, or chloride of lime, may be set about in different parts of a room to produce a mild disinfecting or deodorizing action. The material should be renewed every two or three hours. If the room is occupied, acid cannot well be added to the chloride of lime, or the air would soon be rendered unendurable by reason of the chlorine disengaged.

A certain amount of disinfection may be effected by suspending in the room cloths saturated with a mixture of carbolic acid and camphor. Or cloths dipped in solutions of zinc salts or of perchloride of iron may be hung around in the same manner.

Moistened heads of matches, or a mixture of sulphuric acid with potassium permanganate, may be used to develop ozone, and thereby improve the air of the room.

A bad odor may often be removed by burning a little sugar or ground coffee wrapped in paper. The effects of such deodorants last but a short time, and unless the source of the bad odor is removed, they are of but little value.

If the room can be vacated for several hours, it should be thoroughly fumigated with chlorine or sulphurous acid gas, the latter being preferable. Before fumigating by means of these agents, if the walls are papered, the paper should first be scraped off and burned, and the hangings, carpets, etc., should be spread out, in order to expose them as much as possible to the disinfecting action of the gas. The proportions and mode of generating these gases for such a purpose have already been given.

Utensils.—Bowls, spittoons, and similar vessels, especially if used in a sick-room, should be rinsed with a solution of potassium permanganate, or with one of chloride of lime (2 oz. in the gallon). Chamber-pots may be disinfected by rinsing them with a little strong muriatic (hydrochloric) acid. The addition of potassium permanganate or chlorate to the acid will cause an evolution of chlorine, which may sometimes be necessary both for deodorizing and for disinfecting purposes. Vessels containing the discharges of patients should receive the addition of zinc chloride or perchloride of iron, with or without carbolic acid. About half a fluid ounce of the disinfectant per pint of the discharge will be sufficient. Rinsing with potassium permanganate solution after washing is desirable.

Bedding.—Mattresses cannot usually be thoroughly disinfected. The ticking may be rendered safe by boiling in some solution of zinc, etc., or by fumigation and dry heat; but the straw, hair, etc., with which they may be stuffed, can only be disinfected with considerable difficulty. Heating is the best method, but the heat penetrates very slowly, and often imperfectly. The best mode of removing the danger of infection is to destroy the stuffing, preferably by burning. Strong nitric acid, if poured over such material, aids in its destruction. Saturation with solution of chloride of lime, or of metallic compounds, may be used to disinfect them temporarily, but renders them less inflammable.

Bed-linen, cloths, towels, etc., may be disinfected by first boiling them in a solution

of sodium carbonate, or caustic soda or potash (between one and two ounces in every two gallons of water), for an hour and a half or longer, and then, after rinsing them in clean water, treating them in one of the following ways:

1. Expose to a temperature of about 250° F. for from three to six hours. Dry or moist heat may be used. The latter is, no doubt, the most efficacious, but is not so readily managed. Or,

2. Boil for an hour in a solution containing 2 oz. of zinc chloride or sulphate in the gallon. A smaller quantity of the zinc salts may be used, and about an ounce of carbolic acid may be added to the gallon of water.

If the cloths, etc., cannot be at once treated, they should be thrown into a solution containing 2 oz. zinc salts per gallon. Rinse in clear water before boiling with soda.

Potassium permanganate, as already remarked, spoils the color of goods boiled in it. If it is used, it should be in the proportion of one ounce of crystals per gallon of water

Corpses.—Wrap in a cloth saturated in a solution containing to the gallon:

One ounce of carbolic acid,

Or, two fluid ounces of zinc chloride solution (Burnett's solution).

Or, two ounces of zinc sulphate.

If the carbolic acid is used, sawdust saturated with carbolic acid may be placed under the body, especially about the hips.

If either of the zinc compounds is used, dry chloride of lime may be applied in the same manner as the sawdust.

VILLAGE SANITARY ASSOCIATIONS.

BY

ROGER S. TRACY, M.D.,

SANITARY INSPECTOR OF THE BOARD OF HEALTH, NEW YORK.

VILLAGE SANITARY ASSOCIATIONS.

Preventive medicine, as it has been called, is one of those things that are theoretically approved and too often practically neglected. No one doubts its importance. To prevent disease, and limit the deaths to those caused by accident, physical violence, or poisons, and the gradual and painless extinction of the bodily functions which comes with old age —what can be more desirable or more worthy of untiring and energetic effort? But men are so accustomed to look upon disease as an unavoidable evil, that the idea of preventing it by any action of their own seems to have never distinctly occurred to them until within comparatively modern times. As attacks of disease, and especially of epidemic disease, were in early times attributed to the judgment of the gods, all efforts toward prevention were directed toward the propitiation of whatever deities men believed in, or supposed they ought to believe in. The pestilence among the Greeks in Homer is caused by the shafts of an angry Apollo, and the choicest booty of their king is given up to appease his wrath. Cultivated and in other respects intelligent people are even now not ashamed to carry horse-chestnuts in their pockets to keep away rheumatism, or nail a horseshoe on the door-post to protect them from witches.

A great step in advance of this childlike position was made when inoculation was introduced to modify the severity of small-pox. This disease, which had been one of the plagues of the earth, was thus partly stripped of its terrors, and the final blow was delivered by Jenner, in his discovery of the prophylactic power of vaccination. By this simple, painless, harmless procedure, the nations of the civilized world are so far protected against what was once one of the most frequent and fatal of epidemics, that the knowledge of the presence of the disease in any town or village is now received by the inhabitants with comparative equanimity.

The great success obtained with reference to this disease, amounting to a complete mastery of it, led to the hope that other diseases might be controlled in a similar manner. This hope has proved futile, but it has

given rise to a new branch of science, having for its objects the investigation of the laws under which diseases have their origin and are diffused, and the determination of methods by which they may be prevented or limited.

It is somewhat remarkable that the general public is so slow to appreciate the importance of sanitary science. To be sure, the mass of people are always conservative, and either pull upon the skirts of the reformer and hinder in every way his free action, or, if permeated by a truth that has the least touch of the emotional in it, rush in a body so wildly in the new path, that disappointed expectations produce a recoil. This is what history teaches us to expect, and yet it seems as if nothing needed less of demonstration at the present time to show its utility, than vaccination. But what do we see?

Anti-vaccination societies, diatribes against Jenner and the medical profession from platform and pulpit, letters from distinguished statesmen, expressing doubt of its efficacy; and all because, through ignorance or carelessness, a few persons have been infected with other diseases by the operation of vaccination, or a few scrofulous and puny infants have suffered more than is usual from the constitutional disturbance attending maturation.

If this is so with respect to a matter of such evident utility as vaccination, it cannot be expected that general credit will yet be given to the results obtained in the case of other diseases. It is believed by sanitarians that the zymotic diseases are altogether preventable, and also that variations in the prevalence of those diseases, before and after certain sanitary improvements have been introduced, show that we already possess sufficient knowledge to control their diffusion to some extent, and even to prevent in some cases their development. And yet, as such diseases naturally vary in frequency and in severity from time to time, without any clearly appreciable reason, and where no special precautions have been taken against them, it becomes a matter of some difficulty to demonstrate to sceptical persons that sanitary improvements have any effect whatever in controlling them.

We have one criterion, however, by which we can better judge of the effect of sanitary improvements than by the prevalence or fatality of certain diseases, and that is, the bodily vigor or the feebleness of the population. If sanitarians are correct in the assumption that deleterious influences are constantly at work upon every human being, which tend to impair his vitality and induce disease, and that the object of sanitary science is to discover what these deleterious influences are and put an end to them, then every such discovery and every such application of preventive methods ought to result in less debility and less disease among the people where such applications are made; and their effect, if any, would be exhibited most clearly in that portion of the population which is most susceptible to external influences, and possesses the least power of resistance to deleterious ones. This portion is undoubtedly the infants; and the increase or decrease in infant mortality is one of the best means we

have of estimating the sanitary conditions under which any particular community lives. In New York, for instance, with no special change in the character, habits, or surroundings of the population, excepting the alterations of the drainage, sewerage, and ventilation of dwelling-houses, with enforced cleanliness and observance of other sanitary laws, under the direction of the Board of Health (organized in 1866), the infant mortality has steadily diminished; and while the children who died under the age of five years in 1867 constituted fifty-three per cent. of the total mortality, the percentage has steadily decreased year by year, until, in 1877, such deaths were but 46.96 of the total—surely a remarkable showing. Some of the illustrations given by English statisticians are quite as significant.

Such results are at length beginning to produce some effect on the public mind. It has for some time been evident to medical men that, in the very near future, preventive medicine is destined to hold a commanding place in the economy of society. But the pioneers in the work have had to struggle under many discouraging circumstances. Only their interest in the science, and their confidence in its future, have urged them on. Now that public interest begins to facilitate their labors, the advance of sanitary science will probably be much more rapid than it has been in the past. Not only are the workers in any field encouraged and aided by the mere knowledge that their labors are appreciated, but public interest implies public support and the bringing of the ponderous but effective machinery of government into play, with its far-reaching agencies, its exhaustless resources, and its unequal facilities for the generalization of observations.

The future of sanitary science is not easy to predict. With the growing distrust of remedial agents in disease, and of all interference with the natural course of the self-limited diseases, there has sprung up the belief that they are all preventable, and a hope that they will all be prevented. It is not too much, perhaps, to affirm that the contagious diseases will some time be blotted out; that epidemics of all kinds will be thoroughly understood and completely under government control—in fact, that there will be no more epidemics excepting on the confines of civilization, bounds which they will never pass; that the nature and causes of endemic diseases will be known, and those causes either removed or rendered harmless, so that endemic disease shall also become a thing of the past. Besides these classes of disease, the investigation of which is already recognized as the duty of sanitarians, and the possibility of whose prevention is also dimly seen, there are many others which will eventually be made much less common than they are now. It has but recently been suspected how large an amount of disease is due to the intemperate use of alcohol, and to the pervasive and subtle poison of syphilis. Within a very few years, cases that formerly passed for dropsy or typhoid fever of peculiar type have been demonstrated to be caused by parasitic animals introduced with the food (trichinosis). Unripe fruit and vegetables and unsound meat are responsible for much disease and not a few deaths.

The control of all these sources of injury will be the duty of the sanitarian.

In addition to these, which may be called external causes of disease, there are certain habits of the individual which tend to lower his vitality and bring on attacks of disease. These, as a rule, must be regulated by himself, and will be the last to feel the influence of sanitary ideas. But it is safe to assert that when sanitary administration becomes a recognized branch of every government, and sanitary knowledge becomes popularized and a part of every common school education, individuals will not be so careless of their lives and health as they are at present, and the slight self-denial involved in the observance of sanitary laws will be more than compensated for by the increased capacity for enjoyment which goes with a healthy body.

The importance of sanitary science being admitted, the question arises of the best method of advancing its study and applying the results of such study. In cities, and large towns of more than 100,000 inhabitants, the interests of citizens are so diverse, the mass of material to be dealt with is so great, and the individuals composing the community have so little acquaintance with each other, that they find it worth their while to employ persons at fixed salaries to conduct the affairs of government. In such offices there is generally enough to do to occupy the incumbents most of their time and render the pursuit of other occupations impossible. In such places, therefore, the sanitary needs are best looked after by a salaried board of health, whose members as a rule are men of the medical or engineering profession, but who require for the proper performance of their duties some acquaintance with the principles of chemistry and physics. These officers should devote their whole time to the work of the board, and should feel that the responsibility for the health of the city rests upon their shoulders.

In towns with a population of less than 100,000, but greater than 10,000, while the work devolving upon such a board of health is less than in the large cities, it is still sufficient in amount to make it desirable that special officers should have it in charge. In towns of this size there can generally be found persons who have studied the subjects of drainage, ventilation, disinfection, etc., and are qualified to advise their fellow-citizens regarding them. In these smaller communities it is esteemed an honor to be tendered an office of this character, and it may generally be filled at a nominal salary, or with no salary at all, as, excepting in extraordinary contingencies, its duties would occupy only a small portion of the incumbent's time.

But in smaller towns and villages, a board of health is not often practicable. There is not enough demand in such places for the services of a sanitary expert to make it worth his while to settle there. The call for such knowledge as his is small at the best, and it is for his interest to live where that call is likely to be greatest, *i. e.*, in a large town. There is usually, therefore, no person in a village who possesses sufficient acquaintance with sanitary science to act as adviser to his fellow-villagers. It

becomes necessary, then, for those villages that desire to enjoy the benefits of sanitary science, so far as it is able to benefit them, to adopt some different method of assuring themselves that their surroundings are made as salubrious as possible.

It seems probable that the best means of accomplishing this end is the formation of village sanitary associations entirely independent of any local government. In small places, the citizens are so well known to each other by reputation or personal acquaintance, that such associations could be made to work harmoniously, effectively, and cheaply. Before entering into the question of their organization, it may be well to consider briefly what the objects of such an association should be.

1. It is desirable that all the houses in the village should be carefully inspected with reference to their situation, construction, drainage, ventilation, exposure, etc. Defects in any of these particulars should be remedied. Not only dwellings should be thus examined, but shops, stables, and public buildings. The possibility of the pollution of wells, cisterns, and running streams, by the drainage of houses, stables, factories, cemeteries, etc., should be borne in mind and carefully guarded against. The nature, position, and number of shade trees are matters of importance. In many villages these are so large and numerous, and surround the dwellings so closely, as seriously to interfere with the proper and healthful supply of light and air. A cottage, covered with woodbine or honeysuckle, and embosomed in trees and shrubbery, so that only glimpses of its white can be seen from the highway, is a very pretty addition to the charms of a rural landscape, but the interior of such a dwelling is often gloomy in the extreme, and the depressing mental effect of the sunless rooms is added to the physical injury caused by the deterioration of the atmosphere, which always takes place where the light never penetrates. Trees should be planted with great discretion, and never in such situations that the sunlight will be kept out of a room by them during the whole day.

This inspection of dwellings and grounds should take place at least once every year, for the corrosive effect of the gases contained in the soil- and waste-pipes, the assaults of rats, the expansion of frozen contents, etc., may at any time break a pipe or dislodge the luting of a joint, and give free vent to foul and dangerous gases. Obstructions are also liable to occur from various causes, which, if not removed, may eventually have inconvenient, if not serious, results.

As the other details falling under this heading are mainly those of construction, and improvements once made in that direction are permanent, the methodical annual or semi-annual inspection which is recommended will have mainly to do with the house drainage.

2. The water-supply of the village and of the individual dwellings ought to be occasionally examined, both analytically and with the microscope, particularly that which is used for drinking and other table purposes. The original quality of the water is of importance as regards the health of those who use it, an excess of the lime-salts, for instance, being as injurious in the long run as a marked deficiency. In the country, much

more than in cities, the water of wells and cisterns is likely at any time to be polluted by the escaping contents of house and stable drains, cesspools, privy vaults, etc. Many cases of disease have been traced to the use of water polluted in these ways, under circumstances that admit of no other explanation of their origin.

3. Examinations of food should be made from time to time. Although there is doubtless much exaggeration in the newspaper statements as to the frequency and the dangerous character of adulterations, some adulteration is practised, and in articles of food where it is likely to do harm. Some of the simpler methods of detecting these may be employed by any person, with only the instruction to be obtained from books, while others require more elaborate chemical tests and expert microscopical examination. It is not intended to suggest that every mouthful of food should be subjected to these tests before it passes the lips, but there should be means at hand of obtaining a proper examination of suspected matters. Not only manufactured articles are to be thus examined, but meats. It is not too much to require that at least all pork which is to be eaten raw or half-cooked, should invariably be examined with the microscope before it is used as human food.

4. Disinfection should be made a special study. Owing to the elaborate and painstaking investigations of German, French, and English chemists and physicians, we are beginning to have a practical knowledge of the properties and methods of action of many substances used as disinfectants. Some of these are useful for one purpose, and others for another, and they are by no means to be used, as they so often are, without discrimination. Intelligent employment of them, with reference to the principles on which they act, can of course only be made by one who understands something of chemistry, but plain and detailed instructions may be framed, which will enable the laity to use them with more discernment than at present. They are useful in the abatement of the ordinary nuisances caused by dead animals, stables, privy vaults, compost-heaps, etc., but are of paramount importance in the management of contagious diseases.

5. There should be some way of obtaining good advice as to the management of epidemics. Much of the terror and helplessness displayed by our rural population when epidemics visit them comes from ignorance of their nature and of the means of combating them. To be sure, our knowledge of the causes of epidemic diseases, the method of their propagation, and the best means for controlling their spread, is yet in its infancy, and still enough of success has been attained in particular instances to give us great encouragement for the future.

The neglect of all attempts to control epidemics is at present a marked feature of country life. When scarlet fever or diphtheria appears in a virulent form in a rural village, attention is much more likely to be paid to prayer-meetings, fasts, and acts of religious devotion generally, than to personal efforts for self-protection. Attention to one's religious duties is praiseworthy enough, though the sincerity of such devotion may well be

questioned when it is chiefly displayed in the presence of a pestilence. However this may be, enough is known already of the nature of such diseases to render it certain that their prevalence in a community and their continued devastation are to be attributed to the ignorance, carelessness, or obstinacy of the people themselves, rather than to the direct fiat of the Almighty. It would be well if the inhabitants of every village could be brought to believe and act upon the belief, that they themselves, and not Divine Providence, are responsible for the condition of things.

6. Such associations may do much toward the investigation of epidemic diseases. These are still so imperfectly understood, that all the information that can possibly be obtained respecting them is needed. Every case of such disease, whether contagious or not, should be carefully investigated, and all essential particulars of its history recorded in such a way as to be easy of reference. There are many questions waiting for a solution. Epidemic diseases rarely attack every inhabitant in a place. Why so? What is the difference in constitution, habits, mode of life, age, sex, etc., that renders certain persons safe? Do such diseases ever originate *de novo?* If so, under what circumstances? Why does the mortality of epidemics vary from year to year? At how great a distance can the contagious element of a disease produce its effect? Why are certain persons so much more severely affected than others? Do facts bear out the germ theory of such diseases?

To facilitate the investigation of such problems, it would be advisable to have printed forms to be filled out by the observer, and afterward revised by the proper persons. The following blank may serve to illustrate what is meant, and to suggest some of the points which should be attended to.

Case of Contagious Disease.

1. Name (initials)?
2. Age?
3. Sex?
4. Occupation?
5. Race?
6. Nationality?
7. Height?
8. Weight?
9. Complexion?
10. Hair and beard (abundant or scanty, coarse or fine, straight or curled. Color: If gray, color in youth)?
11. Eyes (color, defective vision, etc.)?
12. Temperament?
13. Hereditary taint?
14. Habits of life (sleep, eating, drinking, etc.)?
15. Physical condition at time of attack?
16. Previous diseases?
17. Date and manner of exposure (known or possible)?
18. Date of first symptoms?
19. Character of disease (pulse, temperature, etc.)?
20. Duration?
21. Complications?
22. Death (cause of)?
23. Remarks.

In cases of epidemic diseases, which are believed not to be due to contagion, other particulars are required in addition to those given above, as follows:

1. Any recent change in habits of life (unusual articles of food, etc.)?
2. Source of drinking-water used by patient?

3. Location of office, work-room, and sleeping-room?
4. Proximity to focus of epidemic?
5. Sanitary condition of dwelling (drainage, situation, exposure, air, light, etc.)?
6. Prevalence of disease among animals and vegetables?
7. Any prophylaxis attempted?
8. Disposal of excreta?
9. Meteorological conditions (prevalent winds, temperature, barometric pressure, hygrometric condition etc.)?
10. Character of the season (wet or dry, cold or hot, etc.)?
11. Character of previous winter or summer?
12. Previous epidemics in place?

Many other questions will suggest themselves to those who think upon the subject in earnest.

Quite as important is the investigation of endemic diseases, which are so prevalent in many parts of our country. The type and exemplar of such diseases is the malarial fever, which takes upon itself so many forms, and causes so much misery and so many broken constitutions in the West and South-west, and which shows itself with something less of intensity at various points along the Atlantic coast. Typhoid fever can almost be called endemic in the beautiful valley of the Connecticut, and tetanus in a certain district of Long Island. These diseases are due to local causes, and it is altogether probable that these causes will at some time be ascertained; and when they are once known, means can be adopted for their extinction.

The blanks for recording such cases should contain some questions which are not necessary for the records just mentioned. Especially important are those relating to the character of the soil and vegetation, and the geological and topographical peculiarities of the country. The following questions might be inserted in the blank:

1. Character of soil and subsoil? Alluvium? Clay? Sand?
2. Prevailing vegetation?
3. Character of rock and stone in vicinity? Volcanic? Stratified?
4. Mountain, valley, or plain? Soil well drained? Swamps? Ponds? Frequent freshets? Etc., etc.

The above suggestions are but indications of what village sanitary associations may find to do. I have only attempted to draw in broad lines a scheme which may possibly some day be filled out by others in detail.

Such being in general the objects to be had in view by village sanitary associations, it remains to consider the best means of accomplishing these objects. It needs no argument to show that more thorough and valuable work will be done if a regular organization is formed, with proper officers, each of whom has special duties to perform, to which he is strictly confined. The less of laxity there is in the formation and management of such an association, the more reliable will be its reports and records, and the more valuable its advice and assistance to its members.

The first step is to form a society, however small, as a nucleus, around

which growth may take place. Such a society will naturally, at first, be composed of the most intelligent people of the place, and of those who understand its objects and something of its methods of working. This will render the matter of organization an easier one than it would be, for instance, in a political club or a debating society, where every one is so anxious to be first as to create disorder. A president is necessary, and a vice-president, to take his place when he is absent. A recording secretary is absolutely essential, as not only the minutes of the meetings, but many of the communications and papers must be filed and preserved. It is well to have a corresponding secretary; for, if the association is successful, it will be desirable, and, in the case of epidemics, perhaps necessary, to have official communication with other similar bodies. A treasurer will be needed; for, although the expenses need not be great, there will be some printing to be done; and the services of experts, who may be called on, must be paid for. This makes up the list of the necessary executive force of the association.

The management should be entrusted to a number of persons chosen from among the members of the association, who may be called trustees, committeemen, councilmen, members of an advisory body, or by any other name that seems appropriate. They are to constitute the brains or guiding force of the association, and are to manage all affairs, excepting such as by the terms of organization are reserved for the action of the association as a whole. The size of such a committee must, of course, vary with the size of the body from which it is taken; but it should consist of at least three members, and should rarely include more than nine, or it may become unwieldy. The number of members, it is almost needless to say, should be odd, so as to avoid tie votes; although it is perhaps worthy of consideration whether it might not be well to have the number even, and refer all tie votes to the general body of members for discussion and final decision.

It will of course be necessary sometimes to call in the services of sanitary experts for the inspection of houses and grounds, and for chemical and microscopical examinations. Such services must be remunerated; and it is better that the advisory body should fix such fees beforehand, and should make arrangements with certain men, so as to be able to obtain their advice when it is wanted. If there is such an expert living in the place, he may be engaged at an annual salary, or be paid in fees, as the association may think best. In extraordinary cases, where there are unusual difficulties in the way of an investigation, or special knowledge or finely trained abilities are needed, it may become necessary to employ a specialist of wide reputation, at a greatly increased expense. It would probably be advisable to refer such matters to the whole association for decision.

One or two suggestions with regard to the formation of the advisory body, council, or committee, may not be out of place. If the scheme above sketched be followed out, or if the scope of the association includes the investigation of the causes of special outbreaks of disease, there will be

many questions of evidence before it for examination. The reports of cases of disease, of circumstances, of local characteristics, of supposed cases of contagion, etc., will come before it for approval before being placed upon the records. Every such report must be carefully read, the evidence sifted, and the conclusions tested. To do these things properly requires a company of men who are used to the examination of evidence; and inasmuch as what is evidence to a physician is not always so to a lawyer, and, *vice versa*, as different men, by their different modes of life and different habits of thought, look at the same subject from different sides, it is desirable that this critical tribunal should be as many-sided as possible. It should, at all events, include a lawyer, a physician, and a practical business man, and, if it consists of a sufficient number of members, should include also an architect, a plumber, and a civil engineer, though the latter can be called in as experts to assist the deliberations of the former. The choicest tribunal would be the one first named, for its members would all have minds trained to work well in certain different directions; they would all be accustomed to the weighing of evidence, and, having no pet theories to exploit, would not be apt to be biassed.

It would be absolutely necessary for the successful working of such an association that its members should have free access to books of reference on the subjects about which they would need advice. There are many excellent books on drainage, food and water, epidemic and endemic diseases, which are intelligible to non-experts, and which, if properly availed of, might often enable them to do without expert services, excepting in cases of unusual obscurity. The association should therefore have a library, kept in some place where it could readily be consulted by members. For this and other reasons which will suggest themselves, it would be advisable to have a special room for meeting, instead of going to the houses of members. The latter practice would soon involve the preparation of refreshments, and what were intended at first to be purely business meetings would degenerate into occasions of social festivity, which would eventually prove fatal to the interests for which the association was formed. In the meeting-room or office the library should be kept. A good collection of books upon these special subjects may be made at a comparatively small expense. The following may be suggested as a nucleus for such a library:[1]

Fothergill: The Maintenance of Health. London, 1874. $2.00.
Cameron: Manual of Hygiene. London, 1874. $4.20.
Blyth: Dictionary of Hygiene and Public Health. London, 1876. $11.20.
Parkes: Manual of Practical Hygiene. London, 1878. $6.00.
Slagg: Sanitary Work in the Smaller Towns and in Villages. London, 1876. $2.50.
Waring: Sanitary Drainage of Houses and Towns. New York, 1876. $2.00.
Denton: Sanitary Engineering. London, 1877. $10.00.
Hellyer: The Plumber and Sanitary Houses. London, 1877. $3.50.
Egleston: Villages and Village Life. New York, 1878. $1.75.

[1] These works may be procured through any bookseller, or from Messrs. Wm. Wood & Co., New York.

Latham: Sanitary Engineering. London, 1878. $12.00.

Bayles: House Drainage and Water Service in Cities, Villages, and Rural Neighborhoods. New York, 1879. $3.00.

Smith: Foods. New York. 1873. $1.75.

Hassall: Food: Its Adulterations and the Methods for their Detection. London, 1876. $9.60.

Fox: Sanitary Examination of Water, Air, and Food. London, 1878. $4.00.

The manuals of Parkes and Cameron give information regarding disinfection and the care of contagious diseases. The choice of works on epidemic and endemic diseases had better be left to the medical member or members of the association.[1] Seventy-five or a hundred dollars would buy an excellent working library and all the journals needed. Among periodicals, some of which should certainly be taken for the general use, the following may be recommended:

The Sanitary Record (weekly). Published in London. Subscription price, 19s. 6d.

The Sanitarian (monthly). Published in New York. Subscription price, $3.00.

The Plumber and Sanitary Engineer (semi-monthly). Published in New York. Subscription price, $2.00.

The further details of organization must be left to be specially determined in each case. The situation of a village, the character and habits of its population, its wealth or poverty, intelligence or stupidity, render the conditions under which such an association must exist so variable, that it is impossible to frame a constitution and by-laws to suit all cases. There are at present but a few such associations in existence, and these are nearly all in Great Britain, which in sanitary science leads the world. The oldest one of which I have been able to find any account was founded at Tottenham, in 1871. One was established in Edinburgh in 1878, and shortly afterward one upon the same plan as the latter was formed at Newport, Rhode Island, which is believed to be the first of its kind in this country. The Edinburgh and Newport associations confine themselves chiefly to the examination of the sanitary condition of dwellings and the analysis of water. The latter may serve as a model for others in this country, and its organization may be understood from the following statement, which has been printed and circulated by order of its council:

THE SANITARY PROTECTION ASSOCIATION OF NEWPORT, RHODE ISLAND.

(Established November 11, 1878.)

OFFICE, GAS COMPANY'S BUILDING, THAMES STREET, ROOM NO. 9.

[The officers of the Association consist of a "council" of eleven, including the president, vice-president, recording secretary and corresponding secretary, a consulting engineer, an inspecting engineer, and an analyst.]

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[1] For a more complete list of the works which it would be desirable to have in such a library, consult the bibliography at the end of the introduction, and also the lists that accompany some of the other articles in these volumes.

The Secretary will be at the office of the Association daily, from 11 to 12 A.M., to receive applications for inspection, etc.

GENERAL OUTLINE OF THE OBJECTS OF THE ASSOCIATION AND PRIVILEGES OF MEMBERS.

1. To provide its members, at moderate cost, with such advice and supervision as shall insure the proper sanitary condition of their own dwellings.

2. To enable members to procure practical advice, on moderate terms, as to the best means of remedying defects in houses of the poorer class, in which they may be interested.

3. To aid in improving the sanitary condition of the city.

The first inspection does not cause any disturbance to household arrangements. It is followed by a report making specific recommendations, if any improvements in the household arrangements are thought necessary. The members are not bound to carry out these recommendations.

The subsequent annual inspection will, so long as the sanitary arrangements remain in working order, entail no expense beyond the annual subscription.

The following is a formal statement of the privileges of members. The annual inspection spoken of in the second paragraph will form the main business of the Association. It is believed that no system of drains, or other sanitary appliances, can be depended upon to remain in perfect order without skilled inspection; and this skilled inspection can be cheaply and efficiently provided by the Association.

Each member is entitled to the following privileges in respect of property within the municipality of Newport:

1. An immediate report by the Inspecting Engineer of the Association on the sanitary condition of one dwelling or property, with specific recommendations, if necessary, as to the improvement of drainage, water-supply, and ventilation, and a report upon the water by the analyst.

2. An annual inspection of his premises, with a report as to their sanitary condition.

3. Occasional supplementary inspection and advice concerning the dwelling or property in respect of which he is a subscriber.

4. Each member by his annual payment secures the above privileges in respect of one dwelling or property occupied or designated by him. Should he be interested in two or more dwellings or properties, as owner or occupant, he may secure equal privileges in respect to them all, by paying the annual subscription for each.

5. A report, to be obtainable on payment of a special fee, on any dwelling or property, or plans thereof, which he may wish to hire or purchase.

6. Reports by the officers of the Association as to the sanitary condition of any dwellings or properties of the very poor, on payment of a moderate fee.

7. A report, without fee, upon the sanitary condition of any public building, as church, school-house, or place of public resort, within the city of Newport.

SANITARY PROTECTION ASSOCIATION, NEWPORT, RHODE ISLAND.

Objects of the Association.

The objects of this Association, based upon that recently found so successful at Edinburgh, and the first of the kind, so far as known, as yet established in this country, are, as already more briefly stated, threefold:

1. To provide its members, at moderate cost, with such advice and supervision as shall insure the proper sanitary condition of their own dwellings.

NOTE.—The cost of precisely similar reports to those furnished by the Association to its members, would, to private individuals employing the same experts, or others of the same standing in their professions, amount to at least four times the sum.

2. To enable members to procure practical advice, on moderate terms, as to the best means of remedying defects in houses of the poorer class, in which they are interested.

3. To aid in improving the sanitary condition, and consequent good repute of the city, by following such course as, in the opinion of the Council, may seem calculated to promote this object.

The Association, in reality a mutual insurance company for the preservation of private and public health, is not intended as a substitute for municipal inspection, and will not conflict with the public authorities, but will supplement their action.

The Association will, however, be in a position to bring to the notice of the public authorities any infractions of their regulations, which, in the opinion of the Council, may call for the adoption of this course. To this end it will receive and patiently consider complaints of sanitary defects or nuisances, public or private, within the city limits.

Conditions of Membership.

Persons become members upon payment of an annual subscription which, for original members, is limited to six dollars for permanent residents of Newport, and ten dollars for those whose houses are closed for a portion of the year; this difference being based upon the fact that premises continuously occupied are more likely to be kept in good order, and therefore to require less rigid and expensive examination. Membership shall cease upon failure at any time to pay this annual subscription within three months after it shall have become due.

At any time after June 1, 1879, the Council shall have the power to increase the annual payment to be made by new members, but they shall not have the power to increase the annual payment to be made by original members.

Privileges of Members.

Each member shall be entitled to the following privileges in respect of property within the municipality of Newport:

1. A report by the Inspecting Engineer of the Association on the sanitary condition of one dwelling or property, with specific recommendations, if necessary, as to the improvement of drainage, water-supply, and ventilation; and a report upon the purity of the drinking- or cistern-water by the Chemical Analyst. These reports will be obtained upon joining the Association, or as soon thereafter as may be. Should the Inspecting Engineer consider it necessary, for the thoroughness of the examination, to employ a laborer for opening wainscotings, lifting floors, digging along the course of a drain, etc., the actual expense of the same will be charged to the member interested.

NOTE.—No obligation will rest on members to carry out the recommendations made to them.

2. An annual inspection of his premises, with a report as to their sanitary condition.

NOTE.—No single inspection of any premises will secure permanent efficiency. Methodical inspection from time to time is absolutely necessary as a protection against inevitable decay, neglect, and accidental disturbance. Examples of failure where design and construction were good are of daily occurrence, and are due to such causes as the gradual stopping of pipes and drains by kitchen grease and rubbish, the corrosion of metal pipes, the fracture of earthenware pipes, the stopping of ventilating openings by dirt, and the pollution, from various sources, of the water-supply. The prevention of disease is infinitely better, for the individual and for the community, than attempts, too often futile, at its cure.

3. Occasional supplementary inspection and advice concerning the dwelling or property in respect of which he is a subscriber; as upon the outbreak upon the premises of any serious or suspicious disease, or during the prevalence of an epidemic.

NOTE.—"It is unfortunate that sewer-gases are not more offensive to the senses, as it is only in extreme cases that the leakage can be detected by the smell. Owing to this odorless impregnation of the atmosphere with emanations from the sewers, languor, stupor, headache, nausea, loss of appetite, disturbance of the bowels, and even low fevers caused by sewer-gas, often make their appearance in families without arousing a suspicion of their true cause.

"House-drains and waste-pipes, to be safe, must at all times be air- and water-tight and have ample ventilation. Every dwelling should have a distinct and separate sewer-connection. This should be properly trapped near the street; should be constructed of iron with tight joints, or of vitrified earthenware or cement with tight joints, not of common mortar, and the bed on which the sewer rests should be thoroughly rammed to prevent subsequent settling of the pipe. The soil-pipe, where it enters the sewer, should be properly trapped and securely joined, and should be made of iron with well-leaded joints. The waste-pipes from the basins, water-closets, sinks, and bath-tubs should be well trapped. The soil-pipe should be extended through the roof, of undiminished diameter, to secure constant ventilation, and prevent siphoning. Specially objectionable are the old-fashioned brick drains and leaden soil-pipes." Pipes and drains should always be carefully protected from the frost.

4. Each member, by his annual payment, secures the above privileges in respect of one dwelling or property occupied or designated by him. Should he be interested in two or more dwellings or properties, he may secure equal privileges in respect of them all by paying the annual subscription for each. The Council will determine in each case what shall be considered one dwelling or property.

5. A report, to be obtainable on payment of a special fee of three dollars, on any dwelling or property, or plans thereof, other than that in respect of which he pays an annual subscription.

NOTE.—This privilege is meant to enable intending occupiers to avail themselves of the services of the Association.

6. Reports by the officers of the Association as to the sanitary condition of any dwellings or properties of the very poor, on payment by the member requesting it of a fee of one dollar.

NOTE.—It is understood that no premises will be inspected unless the occupants themselves consent to the inspection.

7. A report upon the ventilation, etc., of any school-house, church, or other public building, whose sanitary condition, if faulty, may imperil the health of a citizen or member of his family. The expenses of such inspection will be met from the general fund of the Association, and the reports thereof be accessible, upon application, to every member.

8. A vote in the election of the Council, who manage the affairs of the Association.

Meetings.

A meeting of the Association will be held annually on the second Monday of November, at 4 P.M., at which a council of eleven members will be chosen, four of whom shall at any time be a quorum.

The Council shall meet as often as from time to time may be found necessary for the disposal of business, and have power to call extraordinary meetings of the Association when they think proper.

Officers of the Association.

COUNCIL.—The affairs of the Association shall be managed by a council, who shall receive no remuneration, and who shall be elected by the members of the Association from among their own body. The Council shall from their body elect a president, vice-president, recording secretary, corresponding secretary, and treasurer.

The Council shall have power from time to time to frame by-laws for the better

administration of the Association, and to extend its influence, but not to alter the general objects of the Association.

The Council shall appoint, and shall have power to dismiss, all paid officers of the Association. These officers shall consist of a Consulting Engineer, an Inspecting Engineer, and a Chemical Analyst.

All expenditure of the funds of the Association shall require the sanction of the Council.

Recording Secretary.—The Recording Secretary shall keep the minutes of the meetings of the Association and Council, and a register or list of all communications, reports from the Inspecting Engineer and Analyst, complaints of public and private nuisances, etc., etc., which may be made to the Council, in the order of their dates. He shall prepare, and cause to be issued to all the householders and owners of real estate in Newport, and to such other persons as the Council may direct, printed copies of a circular setting forth the objects and privileges of the Association.

Corresponding Secretary.—The Corresponding Secretary shall attend to such correspondence on behalf of the Council as may tend to assist in the general establishment of sanitary protection.

Treasurer.—The Treasurer shall receive and take charge of the funds belonging to the Association, collecting the money when due, and granting the necessary receipts. He shall likewise make payments on account of the Association, under the direction of the Council. He shall keep regular books of accounts, and his accounts shall be periodically audited by a committee of the Council. He shall at the Annual Meeting submit an abstract of the income and expenditures of the Association for the preceding year.

Consulting Engineer.—The Consulting Engineer shall give advice to the Council when requested to do so, both as to general principles and particular cases presenting any difficulty. His remuneration shall be fixed by the Council, and based solely upon the amount and character of the services rendered.

Inspecting Engineer.—The Inspecting Engineer shall visit the premises of members as soon as possible after receiving notification to do so, and shall in all cases report in writing to the Council, who, when they have approved the report, will transmit the same to the member interested. In cases of emergency, a verbal report shall also be made by him to the member interested. His remuneration shall be fixed by the Council.

Chemical Analyst.—The Analyst shall carefully examine such specimens of water as may be referred to him by the Council, and his remuneration shall also be fixed by the Council.

It will be observed that the main object of this association is to enable its members to obtain the services of a sanitary expert at a cheaper rate by clubbing together than they could do separately. It is eminently a society constituted for personal ends, and not for the general benefit. There is a dash of public spirit in the proviso that any member, by payment of a special fee, may have public buildings inspected, and also the dwellings of the poor in whom they may be interested; but the aim of the association is essentially private, and there is no provision and no indication of any desire for the collection of the eminently valuable information which it is within the power of such a body to gather.

In a place where regularly constituted municipal authorities have charge of the public health, and where the management of an epidemic would naturally devolve upon them, the proviso of the Newport Association, that "no obligation will rest on members to carry out the recommendations made to them," is admissible, and perhaps in an association of precisely that character is necessary, in order to secure the adhesion of

many desirable members. But the members of village associations falling within the scope of this article should be made to feel that certain obligations are imposed upon them. They should, it seems to me, be obliged to comply with the orders of the advisory body, or, at any rate, of the full meeting of members, or else sever their connection with the association. There is supposed to be in such villages no health official, and no public authority whose duty it is to control the spread of disease. The recommendations made by this self-constituted protective association will be, in many cases, the result of mature deliberation, and intended to inure to the advantage of the public as well as to that of the individual. If, by reason of the probable expense, or trouble, or inconvenience, he considers it better to decline to comply with suggestions, he must feel that he is perhaps not the only one whose interests are to be consulted, or whose home is to be protected. The precise limits of the authority of such an association must, of course, be determined by each community for itself.

The field marked out in this chapter is probably too extensive to attract at present the tillage of persons who are not especially interested in the growth of sanitary science; but village sanitary associations may be formed for only one or two of the purposes mentioned. It could not be a loss, and would almost certainly be a great gain to any community, to form such a body. Unless the preposterous claim be maintained that villages are now as healthy as they can be, and that there are no unsanitary influences at work in them, then there must be room everywhere for sanitary improvements. When these are carried out, the health of the people must necessarily be bettered. This means not only a smaller death-rate, and less sickness, but a positive increase of vigor, and a consequent increased enjoyment of life. Healthy people are the happiest, whether poor or rich.

What such an association can actually accomplish may be shown by quoting the results obtained by the one in Tottenham. For the following brief account of this body and its work, I am indebted to the Plumber and Sanitary Engineer (Oct., 1878). "In 1871, Dr. E. H. May and sixty other gentlemen organized such an association, which has brought to an end the pollution of the water-supply, ventilated the old sewers and had new ones built, abated nuisances, increased the water-supply, and vigilantly supervised the dairies and slaughter-houses. Visible result: in spite of rapid growth of population, the total number of deaths from fevers during the three years 1874, 1875, 1876, was only 23, as compared with 99 during the years 1871, 1872, 1873 ; the deaths from diarrhœa were only 52, as compared with 86; and the seven principal zymotic diseases only 200, as compared with 343. In spite of the rapid growth of population, as evidenced by the fact that the total number of births during 1874, 1875, 1876 was 445 more than during 1871, 1872, 1873, the total number of deaths was only 79 more. As a consequence of the confidence inspired in the public by these measures, in spite of the present general commercial depression, there were less than 200 empty houses in Tottenham in 1876, while in 1871—a time of great commercial prosperity generally—the num-

ber was as high as 600." Such figures really need no comment. They appeal to the pocket of the capitalist as well as to the heart of the philanthropist.

In some places quite extensive works have been accomplished by the co-operation of public-spirited citizens, without the formation of a society as herein suggested. Meetings of citizens have been held, generally with a view to relieving the town from malaria; funds have been raised by subscription or assessment, engineers employed, and thorough drainage of suspected spots carried out, with very gratifying results. This has been notably the case at Bay Ridge, in the immediate vicinity of New York. Although in these cases the work is not that of a sanitary association, yet it is done with private funds, and under the supervision of private individuals, and serves well to show what energy and public spirit can accomplish in this direction. The following account of the work at Bay Ridge was kindly furnished by Geo. T. Hope, Esq., who was appointed commissioner to supervise and direct the work in company with Messrs. Adrian B. Denyse and Rulof Van Brunt.

"Bay Ridge adjoins the southerly edge of Brooklyn, and is bounded toward the west by that entrance to New York harbor called 'the Narrows.' The land rises from the water by irregular gradations, until, at the distance of somewhat more than a mile from the shore, an elevation of over one hundred feet above the tide-level is gained, from which point it descends until it reaches the grade of the extensive and level tract, parts of which bear the expressive names of *Flat*bush, *Flat*lands, etc. The Bay Ridge elevation is a continuation of the heights of Prospect Park and Greenwood Cemetery, which stretch through the intervening part of Brooklyn almost to the southerly extremity of Bay Ridge. The westerly slope has lost nearly all of its forest growth, while much of such growth still remains on the easterly slope. The subsoil is nearly everywhere sandy, and is without rock save now and then a boulder. There is found occasionally an underlying stratum of tenacious soil, reddish in color, and known in the neighborhood as "hard pan." This material, which sometimes crops out to the surface, is generally found in patches widely separated from each other. It has been shown in well-digging that the prevailing sandy subsoil reaches down fifty or seventy-five feet below the surface. There has been found also, in a very few instances, during the process of excavating for drainage, a thin stratum of whitish clay.

"Nearly twenty years ago (in 1859) the unusual prevalence of intermittent fevers led a few of the inhabitants to seek for the cause, and a half-day's travel, pioneered by an intelligent and life-long resident, disclosed the fact that, while Bay Ridge contained no marshes within its limits, just beyond its borders, low down on the eastern slope of its elevated portion, and in the Fort Hamilton district, close to its southern boundary, there were to be found a great many ponds and marshes of stagnant water.

"Residents of Bay Ridge and Fort Hamiltou united in an effort to secure legislative authority for removing the nuisance, aud for raising the needed money by assessments upon property in Bay Ridge, Fort Hamilton, and so much of the adjacent district as needed to be drained. An Act to this end was passed and commissioners were appointed to carry it into effect. The law prescribed that the commissioners should not be residents of the districts to be assessed, and at the same time fixed their compensation at an insiguificant sum. The result was that a long time elapsed without action. In the end these commissioners resigned, and the occurrence of the war of secession, and the financial evils apprehended from it, led some of the inhabitants to seek and secure from the legislature an enforced delay in the work. Many of the residents

were opposed to the effort to dry up the sources of intermittent fevers, urging as their reason for this opposition 'that the place was very healthy, that no one had ever died of chills and fever, that that disease was readily known and easily treated, that it was a good thing that their diseases took that form, and that, if the advocates of draining were successful and that fever disappeared, some other form of disease, more dangerous and more difficult of cure, would be sure to take its place!' They fortified their position by an appeal to the large number of people of very advanced ages who had spent their whole lives in the neighborhood.

Notwithstanding these arguments and apprehensions, the parties who favored drainage were unconvinced, and in 1869 the Fort Hamilton part of the district comprised in the original Act was set apart as a distinct drainage district, and the commissioners appointed have accomplished much for the general health under the provisions of the law.

My own intimate relation to drainage is, however, confined to the northerly, or Bay Ridge district, which comprises a large region outside of and northerly and easterly from Bay Ridge, in which outside district the ponds drained were located. In the year following this setting apart of the Fort Hamilton district, the law was revised as to the remainder of the region included in the original Act. The amount to be expended was limited to $30,000, and a provision for appointing as commissioners parties immediately interested and living within the boundaries of the district was included in the amended Act.

Action was promptly taken; the entire amount named in the Act was assessed and collected, and the work was begun. It was soon apparent to the Commissioners that to accomplish the needed work with the means at their disposal required very judicious and deliberate progress. The earlier expenditures were at points where the greatest results could be obtained at the least cost, and they sufficed to drain the water from several series of large ponds and marshes, and leave the land in a condition for profitable tillage. Where a thrifty growth of corn stood in the autumn there had but a year or so before been a large pond, in which one 'rashly importunate' had found her death by suicidal drowning. From that time to this the work has been in a state of judicious progress, the commissioners have been learning better how to perform their task, and the funds have grown from interest on their investment until the expenditures in the work already accomplished exceed the sum originally placed in their hands, while they still have work to do and money to expend.

The matters of greatest interest, however, are: What was drained? How was it done? and, With what effect? In the first place, all of the ponds and marshes which were at a sufficient elevation to permit the water to be drawn off, either into the Narrows or into the lower New York Bay, have been emptied into those waters. This has been done by laying several miles of drain-pipe, which, of course, accomplished its purpose effectually.

In other cases the discovery of what have at some day apparently been portions of a sea-beach, with deep deposits of beach-sand and gravel, has furnished facilities for carrying off great quantities of water.

Successive dry wells or cisterns have been dug and walled up, the water being permitted to flow out of one into the others successively as it rises to a fixed height. These are so arranged that if at any time there is a deposit of any earthy substance that will not permit the free passage of water, ready access can be had to them for the purpose of removing such deposit and substituting clean sand or gravel in its place. No necessity for this has yet occurred, however. The water is led by pipes from the ponds to these cisterns, and the result is the same as would be produced upon a basin full of water by making a hole through its bottom. In effect the bottom is knocked out of the basins which form the ponds. It has been found in the progress of the work that the marshes are formed in places where there is an underlying stratum of the 'hard pan' before spoken of, when the centre of the patch is depressed below the outside edges. These strata are of varying depths, being sometimes but a very few

feet, and in others twenty feet or more in thickness. In other cases wells have been dug so deep as to reach the point of perpetual water, which is found at the tide-level of the bay, and into these the water is led from the ponds by pipes. Such wells require to be occasionally cleaned of sediment, and although they carry the water away but slowly, they have accomplished some good work. In a few cases, and where the sheets of water are always clear and remain full, or nearly so, during the entire year, the extent of the ponds has been diminished by filling in their borders, and these borders have been laid up with stone, or grassed so as to leave no margin of decaying vegetation at any time. The Commissioners are satisfied that noxious exhalations proceed from ponds which are to a considerable extent, if not altogether, dried up by summer heats and droughts, and not from such as have steep sides and are always full. They have become satisfied also that saturated soil is harmful, and many acres of such soil have been drained; acres which had ceased to be tillable have been made fit for the plow early in the spring, owing to the surplus moisture being carried off and emptied into the bay of New York. So far as has been possible in the successive draining of the marshes, the water has been drawn off late in the autumn, in order not only that they should be thoroughly dried up before the return of summer heats, but that the underlying peaty bottoms should in the mean time be subject to the freezing effects of the winter.

"Nine-tenths of the work is accomplished, and, notwithstanding the apprehensions of those who opposed the movement, no new disease has supervened; the inhabitants still grow old, and all now seem willing to dispense with intermittent fever.

"It has been the aim of the Commissioners to secure drainage to the depth of at least four feet below the surface-level, so as to have no saturated soil within that distance of the surface. The ponds and marshes drained exhibit a rich soil, which is soon fit for profitable cultivation, and their tillage is found to promote the object of the Commissioners.

"In looking over this communication, I fear it may be misleading as to the former prevalence of miasmatic fevers. A large proportion of the inhabitants have had no personal experience of them during their residence in the place; and yet they were prevalent enough to make many of the citizens willing to spend money for their eradication.

"In order to furnish more definite proof of the valuable effect of the drainage than the confident belief of the Commissioners and the general declaration of the inhabitants would afford, written inquiries were addressed to two gentlemen whose opportunities for accurate knowledge are superior to those of any others. One of these is Mr. George Self, who for many years has been the proprietor of the principal grocery and general store in Bay Ridge. In his reply he writes: 'In your note you ask me to speak from experience and observation as to the results of drainage in this region. As to my experience, the change is very marked: my sales of quinine, which is the remedy used almost exclusively, are less than one-fourth of what they were ten years ago. I consider this falling off due entirely to the effect of drainage, as my trade for other goods is much larger now than it was then. As to my observation, I don't see, in all my travels around the country, any genuine cases of fever and ague; in fact, chills, as they were usually called, have disappeared A few days ago I had a conversation with the doctor on this subject, and one of his remarks was to the effect that "they (the Drainage Commissioners) have taken many a dollar out of my pocket;" I think I can say the same.' The other party addressed is Dr. Fred. C. De Mund, an esteemed physician, having an extensive and an extending practice in the entire township. His residence is in the village of New Utrecht, which lies a mile or more east of Bay Ridge.

"Under the date of March 26, 1879, he writes: 'In reply to yours of 22d, I can say that the drainage of the ponds and marshes in the town has greatly lessened the consumption of quinine; that the formerly prevailing fevers (intermittent and remittent) are dying out for want of their accustomed food—in fact, we have had very few cases of the old-style fevers for the past few years; and I must credit the work of drainage

for the fact. If the work is, as you say, not yet perfectly done, still it has greatly benefited the community. As regards the new and fashionable fevers of the day, "malarial," we have had very few cases.'

"The progress of the drainage is marked by the progressive banishment of intermittent fever. It is designed that the work shall be completed during the present year; and there is no reason for doubting the complete accomplishment of the purpose for which it was undertaken.

"Those who once opposed the expenditure now express their satisfaction with what has been done; and wherever in other places such facilities for draining exist, it is unwise, and worse than that, to neglect it. The good gained will amply justify the labor and the cost."

In 1874 an association was formed in Irvington, N. Y., called the "Irvington Neighbors." The constitution defines its objects to be the promotion of the highway improvements, the fostering of the æsthetical characteristics, the encouragement of the educational departments, and the conservation of the health of the neighborhood. In the summer of 1878 the increasing prevalence of malarial fevers along the easterly bank of the Hudson River from Dobb's Ferry to Tarrytown, including Irvington, induced this body of gentlemen (at present forty-six in number) to have the territory examined by sanitary engineers, with reference to the eradication of the disease. By the kindness of Mr. Cyrus W. Field I have been able to consult the various printed documents, in which the unsanitary conditions, furnishing a nidus in all probability to the malarial poison, are stated to be the following: too many trees and too much shrubbery in the vicinity of the small streams and ponds, so that, in many places, the ground along their borders is always wet, and is never exposed to the sunlight; the shallowness of these ponds and streams, so that, as the amount of water in them is increased or diminished, considerable areas of land, covered with decaying organic matter, are alternately flooded and exposed to the air; the existence of numerous small tracts of land so situated that they are not properly drained by the natural watercourses, and are therefore covered with shallow, stagnant ponds or marshes; the mingling of salt and fresh water in bogs and marshes along the river-bank, alternately covered by the tide and exposed at its ebb—a result of the building of the Hudson River Railroad embankment along the riverside; and the pollution of the water courses along a great portion of their length by house-drainage and sewage, the leakage from cesspools and privy-vaults, and the refuse of stables, cow-yards, hog-pens, and a slaughter-house and offal-boiling establishment. The recommendations of the engineers included the straightening of the courses of the brooks in places where this seemed necessary; the thorough cleaning of their bottoms and borders; the construction of surface-drains in some places and of sub-drains in others; the removal of shrubbery and trees in various localities, so as to expose the southern banks of watercourses to the sunlight; the removal of all cesspools, privy-vaults, etc.; the general adoption of ash- or earth-closets; the conveyance of the house-drainage by properly-laid pipes into the river where practicable, and otherwise the disposal of it by sub-irrigation; the prevention of the pollution

of streams by stables, hog-pens, slaughter-houses, etc.; the drainage of low, marshy lands east of the railroad by pipes opening into the river just above low-water level, and furnished with flap-valves to prevent the influx of tide-water; and the partial closing of the inner or shore end of the railroad culverts by a wall of cemented masonry higher than the highest tide-level.

The attempt on the part of certain citizens to carry out some of the recommendations above mentioned has resulted in litigation, and the sanitary improvement of the locality is therefore for the present in abeyance.

Besides the effect of such improvements upon the physical well-being of the rural population, there will be other results of even greater importance. The duties devolving upon the members of such associations will bring them face to face with some of the great problems of the age, and make them acquainted with the thoughts of the best minds upon the subjects in hand. With an increase of knowledge on sanitary matters will come an interest, more or less vivid according to the natural fervor of individual character, in the prevention of disease. People will begin to take pride and joy in the fact that the wand so long held by what may be called the medical priesthood, is now in their own hands. They will begin to realize that disease, so far from being due to the operation of occult forces and only intelligible to those learned in the jugglery of the schools, is produced by causes which are largely within their own control. This opinion is even now expressed freely among the laity, but it still sounds too much like the echo of a medical preface, or the senseless repetition of a well-trained parrot, and not like the expression of a vital and earnest conviction.

With such a conviction will come, hand in hand, an increased appreciation and understanding of science and its methods of investigation and proof. Scientific men are now looked upon by people in general somewhat askance; they are considered dogmatic, opinionated, and supercilious. When people come to do a little scientific work for themselves, however, and find out how carefully every observation must be taken and every source of error avoided, they will learn how much more reasonable it is to be dogmatic about facts than about inferences, and how difficult it is too for one to avoid the appearance of being opinionated and supercilious, when he is forced to discuss a question with all the facts of which he is familiar, with a person who evidently knows not enough of the subject even to be aware of his own ignorance. They will gradually acquire that accuracy of observation and precision of statement which are so necessary in ascertaining and imparting the exact truth, and the mental training they gain in this way will be of immense advantage to them in other pursuits.

There is a wide field for speculation in estimating the probable or possible advantage to the commonwealth, which might result from such general and extensive observation of diseases and their modes of propa-

gation and dissemination. To the hundreds of persons who now collect facts bearing on the characteristics of epidemic and endemic diseases, millions would be added. The number of tabulated facts might become so immense, that, instead of theories upon these obscure subjects, we might discover laws, and then we should have a substantial grasp on the throat of every pestilence. Moreover, the advance of scientific knowledge and of scientific modes of thought among the people would give the death-blow to quackery of all kinds. Quackery flourishes in the same soil with superstition. Kill one and the other dies, or rather, destroy the common root of both, which is a habit of inaccurate thought, and both will wither away and disappear.

Such a consummation is far in the future; but earnest, whole-souled work, in even the narrowest of the directions indicated, could not but bring forth wholesome fruit almost with its inception.

SCHOOL HYGIENE.

BY

D. F. LINCOLN, M.D.,

BOSTON, MASS.

SCHOOL HYGIENE.

Site.

In fixing upon the site of a school-house, we should consider that the persons for whom the house is intended are of a class peculiarly susceptible to the influence of bad hygienic surroundings, and that this susceptibility is increased by the closeness of their contact during school hours. Nothing gives a clearer proof of the advanced civilization of a community than the habitual choice of excellent sites for schools. In entering a Swiss village, this is one of the points which first strike the eye of a stranger.

In the climate of the northern United States and of the northern half of Europe, a school-house ought to be so placed as to receive the direct rays of the sun in each room during some part of every day in the year. In order to attain this result, several things must be attended to. The site must not be overshadowed by houses, trees, or a hill. Verandas, however necessary in more southern latitudes, are not proper in ours. All "architectural features," whether intended for beauty or for use, should be strictly kept from interference with the distribution of sunlight. The architect, in planning enclosed spaces, court-yards, or flanking projections, and, in fact, in all cases, even the simplest possible one of a plain square or oblong building, should consider the "orientation" of the rooms, and should know how long, and at what angle, he has a right to expect the sun to shine into each room. It is obvious enough that a room lighted exclusively by northern windows, in a wall running east and west, will have a very deficient supply of sunlight. It is best to place the house so that the *corners* will indicate the four cardinal points, and the *faces* will look to the south-east, south-west, etc. It is unfortunate that the leading streets in some of our great cities, as New York, run in such a direction that this is impossible, and that one side of each house, in most sites, receives no sun for many weeks in winter. A corner site avoids this objection to some extent, and combines the further advantage of a free current of air, from two directions at least, which is of use, not only in summer, but in assisting natural or trans-mural ventilation in winter.

Dampness is a most serious fault in the site for a school building. This may arise from the neighborhood of ponds and swamps, or trees in

excessive number; and must then be remedied by draining or filling[1] the swamp or pond, or felling the trees. It may also be due to the impervious nature of the soil: a difficulty easily remedied, if the site is elevated, by a proper use of drain-pipe and trenches about the house-lot. If, however, it be due to the conformation of the strata giving rise to springs of water on the site of the house, the difficulty may be insuperable. If the water cannot be diverted, the site must not be used; for concrete floors will not keep out water from a cellar built in a saturated soil. An elevated site is generally preferable to a low one, on the ground of better drainage, more abundant sunlight, and a freer supply of air. Even high land, however, is often boggy or full of springs of water.

The bottom of the cellar ought to be at least three feet above the average level of the water in the soil. If this seems impracticable, let tile-drain be run around the cellar at the depth of its floor, and furnished with a discharge at some lower point. In some cases it will be necessary to place the cellar floor at or near the ground level.

Much complaint is made of the excessive dryness of the air in some schools and houses; but this is a slight fault compared with the dampness emanating from floors, walls, and soil, which has been shown by eminent authority to be productive of consumption, catarrh, and rheumatism.

A common fault is excessive *exposure.* On the whole, a high, even a bleak site, is better than a low one; but it is seldom that either is a necessity.

The neighborhood of noisy trades or occupations, or such as pollute the air with smoke, dust, or smell, must be avoided. Foundries, railway-stations, markets, shambles and stables are among the places to be shunned. For certain moral reasons, also, the neighborhood of crowds of people is apt to be undesirable.

Some Points in Construction.

The doors of the school-house ought to open outward toward the street, to prevent a block in case of a panic, such as an alarm of fire occasions. With the same view, it is necessary, in the case of a large school, to make them from eight to twelve feet wide. One such door should be placed close by the foot of each staircase; if possible, directly in front of it. The doorway should always be wider than the stair that leads to it.

The entries and corridors must be spacious relatively to the stairs, especially at the foot of the latter. In large houses a width of ten or twelve feet is required. They should be lighted directly from out of doors when possible; and the lights should be placed at opposite ends, so as to insure a free natural ventilation, which on many days of the year, even in winter, is the best for entries. It is hard to ventilate entries that occupy the centre of schools; while entries or corridors that possess

[1] Filling, without providing an outlet for the water, often results in the production of a permanently damp spot of ground.

a natural ventilation furnish a desirable means of supplementing the defects of the air in rooms.

The staircases should be fire-proof, that is, isolated by solid brick-walls on three sides if possible. Like the entries, they must be lighted from the outside. There must be at least two staircases for a building containing six hundred scholars; and some architects will consider three necessary. The width must be at least six feet in the upper story, and eight in the lower; and the height of the steps must not be too great for young children. Spiral stairs are inadmissible, for the steps are very narrow next the well, and if the child falls on the stair the descent is very steep on that side. Wedge-shaped steps are inadmissible for the same reason, though common in private houses. Wells are dangerous, if not protected; the staircases should be sheathed; balusters are totally unnecessary, and the rail should be about four feet above the riser. A stair which ascends the height of a story without a break is not desirable; one or two landings should be introduced to furnish a momentary resting-place.

A clean, dry cellar is a suitable place for play-rooms, provided the sunlight and air enter freely. If the ceiling is high, a gymnasium may be placed there under the same conditions as to light and air. The floor of such rooms should be of hard stone or face-brick, in order to avoid the dust which comes from softer materials. It is well also to set the stone or brick in cement, and to cement the walls, for dampness must not be permitted to exist. An excellent, but costly, device for floors, lately introduced, consists of damp-proof layers of asphalt and cement in both the floors and walls. No school-room ought to be in a cellar, or even partially underground.

The first and the second stories may contain all the school-rooms; the third, a large hall for daily assembly, and other rooms for cabinets, libraries, laboratories, drawing, music, etc., if required. It is very desirable to restrict school-houses to this height. School-girls in their teens suffer from having frequently to climb to the third or fourth story. The fatigue and annoyance tell upon them; and they are apt to be unwilling to descend for recess, and so lose the benefit of the outer air, while the rooms, in the meantime, cannot be properly aired out during their presence in recess time.

Heating and Ventilation.

This subject has been treated at large in another part of this work. A few special points may, however, be mentioned here.

Excessive cold and excessive heat are both liable to occur. In the typical school-house of American cities, well-built and expensive as it usually is, the latter fault is much more common, and is doubtless a natural concomitant of that "forcing-system" to which our schools seem to tend: a system implying an excess of mental strain (even more than excess of work), which induces a liking for bodily warmth in proportion as it discourages a liking for active sport.

It is remarkable that Americans seem to prefer a warmer room than is agreeable to Europeans. Morin's maximum for schools is 59° F.; Ficker's, 64° F.; Varrentrapp's, 65¾° F. There is among ourselves the same difference in personal liking, some being best suited at 80°, others at or near 64°, and that, too, in natives and inhabitants of the same place.

School-children can, beyond a doubt, be made comfortable at 66° (and even much lower if accustomed to it) in a well-aired room. Of course children ought not to sit with wet clothing in a cool room. Children who are badly fed will not resist cold well; nor those who are pampered, or prevented from getting exercise. And any person, child or adult, may become tender and delicate in a short time by accustoming himself to an overheated room. It is very hard, in a changeable climate like ours, to avoid the latter evil: in most houses there is placed a powerful heating apparatus, which cannot be made to "roar gently" when the weather moderates; and a set of gas-burners is used which raises the temperature several degrees. Attention to the temperature of a house, in our climate, implies quite as much a care for coolness as for warmth during the changeable spring and autumn weather. And, when it comes to the practical working of a school-room, it is very easy indeed to let the temperature exceed a reasonable point, but requires constant attention to keep it down. An interesting lesson may be going on, or a written examination: the mind works well, for the time, at a fever heat; and the temperature of 84° may pass quite unnoticed. It is needless to say that such a strain upon the system is followed by a period of lassitude; and a state of lassitude, again, may demand a slightly raised temperature. Thus, by degrees, habits of preference for hot rooms may be formed. The teacher may be as unconscious of the evil as the scholar; indeed, if fatigued she may require, or if excited may not notice, an unusual heat.

The time to correct bad habits in this respect is the beginning of the school year. Every one then comes to school with a system invigorated by some months of exposure to fresh air; and, if care is taken, this vigor, or power of resisting cold, may be retained. The teacher may assist by causing the children to take frequent exercise—play, with running and shouting, is the best—and to go out of doors frequently. If it rains or snows, windows may be opened a little, while the children are engaged in active bodily exercise, such as calisthenics. These intermissions should occur as often as once every hour, and last five minutes at a time, or longer. Weakly children, those liable to croup or rheumatism or other complaints arising from exposure, must be protected meanwhile; but the fact remains, that the power to perform work, the power to generate heat, and the power to resist catching cold, are all improved by frequent vigorous use of the muscles and lungs.

The personal influence of a vigorous and full-blooded master may be very beneficial in correcting the errors of subordinate teachers in these respects.

The ventilation of a school-room is not altogether a simple matter. By confining ourselves to one method, and refusing to consider others,

we may represent it as simple; but for special cases a variety of plans must be adopted.

The school-room has its characteristic odor, as the prison has. It is probable that a great deal would be gained if we could banish this odor from schools; a sensible freshness usually implies an actual purity of air. Nothing is of more importance in effecting this object than cleanliness. Clean skins, clean heads of hair, clean feet (or well-wiped shoes, if the pupils have them), and clean apparel, can be encouraged by the teacher's influence; and domestic visitations will often effect a great improvement among the poorer class of scholars. The over-garments of the children must be hung in a safe place, with good ventilation and warming, and abundant room to avoid contact between the garments of the children. This place should not be the school-room, but if possible a closet. Daily sweeping of the floors, and weekly scrubbing of all parts of the floor and wainscots in rooms and halls and stairs, should be made thorough by being associated with a good airing-out. As a further precaution in favor of cleanliness, it is recommended to select wood that is not porous. For the floors, hard pine, saturated in hot linseed oil before laying, will give a surface nearly impenetrable to moisture or vapors, which dries instantly when washed, and is very durable.

When all that can be done in this direction has been done, we may turn our attention to the problem of a supply of fresh air.

Here we have before us three questions: 1. How much fresh air shall we furnish? 2. How shall we get it in? 3. How shall we get it out?

The claim of an hourly removal of air to the extent of 100 metres per head (= about 3,500 cubic feet) is theoretically justified. Practically, there is great difficulty in bringing so large a quantity in without causing a draught. A school-room, 25 feet by 32, and 12½ feet high, containing 10,000 cubic feet of air, allows a space of 200 cubic feet per scholar, supposing fifty to be present. It is not practicable to make school-rooms very much larger, nor will school authorities at present consent to reduce the classes to forty, desirable as that step would be. If the supposed room be ventilated at the assumed rate, 175,000 cubic feet of air per hour must be removed from the room; that is, the entire air must be changed 17½ times in an hour, or once in three minutes and twenty-five seconds. If the cubic space allowed be increased to 300, as is actually done in some schools, the contents are discharged once in about five minutes; and if the requisition of fresh air be reduced from 3,500 to 2,000 cubic feet, which may be considered a minimum, the time for discharging the contents of the room becomes about nine minutes. This calculation illustrates the theoretical difficulty, which lies in the danger of producing a draught by the introduction of so much air.

It is, however, allowable to admit warm air, in a horizontal direction, at the ceiling (Degen), at the velocity of one metre (3.3 feet) per second. The air required equals in round numbers 2,000 feet per minute, or 18,000 feet in nine minutes, which presupposes a free aperture of 10 square feet; say five registers without gratings, each one foot wide and two feet long,

which is considerably larger than is usually seen. In any case, a large room is much freer from draught, during the passage of given quantities of air, than a small one.

For smaller rooms, with the same number of pupils, the apertures should be of nearly the same size. As regards the extraction of air, further remarks may be seen under "Ventilation" in this work.

The allowance of 300 cubic feet of space per scholar is claimed by Prof. Kedzie; of 220 cubic feet by A. C. Martin; of 120–284 cubic feet by various German states; and of 70–100 cubic feet, according to ages, by the New York Board of Education. The latter requirement is acknowledged to be inadequate, but the pressure upon the schools under the new compulsory act is so great that even this is, to some extent, an improvement. In Brooklyn, the vigilant eye of Dr. Bell has discovered many bad places; in one examination, made in 1877, he found two rooms containing an allowance of only 15 cubic feet and 2 square feet of floor-space per scholar. As regards German schools, they allow small space and little change of air, and are generally said to be very badly ventilated.

The space required per scholar in Saxony is 5 square feet; in Hessen, 4; in Prussia, 6; in Würtemberg, 8. In Bavaria there are special requirements for different ages; for children of 8 years, 3.9 feet; of 12 years, 5.6 feet, etc. The requirements in cubic space are still more various, ranging from 42 to 221 cubic feet per head.

A few points are here added, without detail, by way of hints:

Double windows check cold draughts, economize fuel, and may aid essentially in ventilation if opened in a certain way.

Evaporation of water in the furnace-box is desirable; the effect is found to be pleasant.

Air-tight windows and joints require a full system of ventilation by flues.

Exposure to a draught of hot air, or to a hot stove, is to be avoided.

The experiment of ventilating schools by a steam-fan ought to be tried. The method by exhaustion through a hot-air shaft is certainly expensive, and the result is largely dependent on weather. That by windows and doors may be employed to advantage in almost all existing cases, as a supplement to the defects of any "system" which has been adopted.

The ordinary open fireplace is another valuable supplement, but is not, in our climate, sufficient or suitable for the entire service of warming a room.

A large house is found in general more difficult to ventilate than a small one of similar construction, especially if there are several stories.

In general, no system of heating and ventilation has been devised which will work automatically, without supervision on the part of the teacher or engineer. In other words, it takes brains, as well as coal and iron, to ventilate a house. The required article is not generally to be had for the sum paid. I think that head-masters, with a certain amount of instruction in the details of management, are better persons to have the

responsibility than janitors; but it would be still better to improve the quality of janitors, and to bring them under a strict supervision by sanitary officers or committees.

The best system yet adopted in schools requires a good deal of watching, and cannot be intrusted to the sole care of a janitor. It is for his interest to appear economical of his coal; he is therefore under a constant temptation to check the outflow of warm air from the rooms, and to limit as much as possible the period of airing-out, which should come daily after school. Good ventilation is an end which cannot be gained without the expenditure of much fuel; for the *foul* air, thrown away, is *warm* air, and the heat it contains is necessarily lost.

There is one point, in respect to ventilation, which has an especial bearing upon the health of schools; I refer to the practice of drawing air for the use of the school from the cellar, the inlet from the outer air being closed. Mention of this improper custom has been already made under the general head of Ventilation and Heating. In the case of schools there is a special impropriety. In winter, for example, the windows of the cellar are extremely likely to be closed; and in many, if not most cases, very few windows are allowed to be open in the school-rooms. Whatever we may say of "natural ventilation"—and there is no doubt of its importance—it remains true that the character of the air of rooms is mainly dependent in winter upon that of the air from the furnaces. Suppose, then, that a school-house containing 800 pupils receives a supply of air equivalent to 2,000 cubic feet per head per hour, or 1,600,000 cubic feet. If we suppose that 100 cubic metres (say 3,500 feet) per hour enter each room by the way of natural ventilation directly from the outer air, we must deduct, for 14 rooms, 49,000, say 50,000 feet from the previous sum, leaving 1,550,000 feet to be furnished by the furnace. If the cellar-story contains an area of 6,000 feet, or a cubical capacity of 60,000, it appears that it will contain a supply of air for the rooms above sufficient to last two minutes and a third. What then must happen? Either the air must pass into the rooms in diminished quantity, or else some new supply must be opened: and both these events doubtless occur. If all the doors and windows of the cellar are kept tightly closed, less air than formerly must enter the hot-air box. But some must continue to enter; and a large part must come from above—*i. e.*, from the school-rooms, through the corridors and at the cellar stairs—following the natural law which compels cooled air to descend. A circulation of foul air is thus established in a few minutes after the inlet from the pure outer air is closed; warmed foul air ascending to the rooms, and cooler foul air descending to the cellar. The practice is absolutely indefensible, so long as the rooms are occupied. It is only allowable after all the scholars have left, and all parts of the house have been most thoroughly aired by opening windows in every part at top and bottom. Then, if the cellar also is perfectly clean, it may be proper to close the valve, and to treat the entire building as a single closed chamber without ventilation, until the school reassembles. It is, in fact, in cold climates, better to do this, not only for eco-

nomical reasons, but because it is likely to prevent the excessive cooling of the house, and tardy heating at the opening of the next session; a fault which is as dangerous as defective ventilation.

The ventilation of evening-schools is made difficult by the presence of smoke, greasy vapor, sulphurous acid, and other products of the combustion of oil or gas. A *well-managed* kerosene-lamp is not often seen in public buildings, but would be both the cheapest and the least injurious. Burning-gas produces a suffocating air, due to the presence of impurities which cannot be wholly got rid of. Tallow-candles are not advisable. When lighted artificially, a room should have the upper ventilators open and in vigorous action.

Drainage.

A few brief remarks will suffice under this head.

It is necessary to condemn the common "privy" as dangerous to the health of scholars. In country schools they are seldom or never cleared out. If the deposits are accessible to the outer air, there is great danger of exposure of the persons of the scholars; if kept in a closed pit, they become notoriously offensive and dangerous to the water-supply. Frequent removal and constant disinfection with dry earth is recommended where there is no water-supply: a large water-tank, inclining to an outlet and flushed daily, for places where water is plenty. In planning a cellar, all such conveniences should be placed in an apartment strictly separate from that containing the furnace or the play-room, and should have access by windows to the outer air.

A privy under the same roof that shelters the school ought not to exist for a moment. It is true that delicate children ought to be spared exposure; it is true that the fear of exposure in winter, or a natural shrinking from the foulness of ill-kept privies, leads many little children to conceal their natural wants, to their bodily harm. But provision for such cases can be made in small country schools by the earth-closet; in large schools there should be a few water-closets, and the main out-house, when there is one, should communicate with the school by a dry covered way. Most children will require to visit the place once in the school-day, and it is not right to turn them out of doors in all weathers for the purpose. This point is almost universally neglected.

Boys and girls should not have to use the same privy. There ought to be two buildings, and not one divided by boards into two parts: a board fence should separate the two sexes in going and coming; and, where present arrangements are bad, the boys should have their recess at a different time from the girls. To insure decency, and to check immorality, a trustworthy monitor might be appointed not only for recess, but to accompany every child who goes out during school-hours.

Many schools, including some in country-towns, report the presence of small water-closets in the first or second stories. If care be taken that these are well aired and cleansed, they are not objectionable, but positively desirable in these situations. There is no doubt that girls especially re-

quire some such accommodation, as in a large class there will always be some who ought not to be exposed to the weather, nor to be forced to go up and down stairs unnecessarily.

Contagious Diseases.

The opinion seems to be well grounded that schools occasionally constitute a medium for the transmission of contagious diseases, and that grave consequences may result from neglect of precautions in the presence of one or more cases of such disease in a school.

In regard to small-pox, varioloid, and scarlet fever, there can be no question as to the necessity of the greatest care in isolating patients, the diseases being at once very dangerous to life and extremely contagious. In regard to other diseases of the same class (zymotic), some degree of difference of opinion may exist among medical men as to the need for isolation.

The following rules[1] for preventing the spread of contagion in schools are made as simple as possible to meet a variety of cases:

Rules for Preventing the Spread of Contagion in Schools.

1. A certificate of vaccination is to be required of every child entering the public schools.
2. Every physician to be required, under penalties, to report to the local board of health all cases of dangerous infectious diseases observed by him, the board to inform principals of schools. What diseases shall be included in this requirement had better be left to the decision of such board.
3. The existence of any case of such diseases in a house, to exclude the inmates from attendance at schools, for a sufficient length of time ; the propriety of readmission being certified to by a competent physician.
4. Disinfection of premises and clothing, by the board of health, in every house where the above diseases have prevailed.
5. Medical authority to be designated, for the purpose of advising teachers and pupils, and pointing out to the school committee matters in regard to which their authority might be used to improve the sanitary condition of schools.

Hygiene of the Eye.

It is generally known that school-work is often associated with impaired sight. This impairment consists in most cases of the development of near-sight, or myopia. Most children at the age of five or six have "normal" vision; a moderate percentage are far-sighted, and a much smaller proportion are near-sighted. This is the case, at least, in America. But, as the age increases, a regular increase in near-sight is observed among school-children in various parts of the world, as Germany, Russia, and the United States. Far-sight is correspondingly diminished, in most cases, while the number of normal eyes is greatly diminished. In Erismann's examinations, in St. Petersburg, the results were as follows: Num-

[1] From Ninth Report of Massachusetts State Board of Health, 1878.

ber of eyes examined, 4,358: percentage of near-sighted eyes in the youngest classes, 13.6; in oldest classes, 43.3. In Conrad's examination, in Königsberg, the number of eyes was 3,036: percentage of near-sight in lowest classes, 11.1 ; in highest, 62.1. In the table of Drs. E. G. Loring and R. H. Derby, of New York, based on 2,265 eyes, the corresponding percentages are 3.5 and 26.78. The period of time covered by these statistics is that between the ages of six and twenty-one years.

These statistics are confirmed by a great number of others, covering, in all, over 20,000 children in Germany and America. They seem to show that, while the Germans are a much more near-sighted race than our own, the same condition of things exists among ourselves to a limited extent, and due to the same causes.

In Germany, Cohn found that, while in village schools there were only 1.4 per cent. myopic, in the city schools of a corresponding age there were over ten per cent. Erismann found that those scholars in the same schools, and under the same influences, who studied most, were most affected with near-sightedness. Of his scholars, all studied two hours out of school, some four, some six, and others over six hours. Of those who studied only two hours, there were 17 per cent. near-sighted; of those who studied four hours, 29 per cent.; while of those who studied six hours, there were over 40 per cent. It is further shown by Cohn that the rate of near-sightedness increases in proportion to the poorness of the light in the school-room and the narrowness of the street in which the school-house stands.

Several causes may thus be traced. In the first place, young children who are near-sighted are evidently so through inheritance. And near-sightedness in parents is believed by the most eminent authorities to be extremely likely to pass to children. Donders declares that it is "more especially proper to cultivated nations, and that, among the states of Europe visited by him, he nowhere, in general life and in cliniques, met with relatively so many myopes as in Germany." The same preponderance of near-sight is seen among the German children in New York, as compared with those of the native American or Irish stock. And, among barbarous tribes who do not go to school, the defect is almost unknown.

In the second place: Residence in a city, with its limited prospects, has apparently some effect in causing myopia.

Thirdly: A bad light is one of the most certain causes. Of this I shall speak later in detail.

Fourthly: Anything favorable to congestion of the head, as a bad position of the body, heat of the room, wet feet, indigestion, excessive length or severity of study without interruptions.

Fifthly: In the words of Donders, "the distribution of near-sightedness chiefly in the cultivated ranks points directly to its principal cause—tension of the eyes for near objects."

Sixthly: "Peculiarities of food, indifference to ventilation, disregard of other hygienic requirements, want of out-door exercise, and a peculiar tendency toward a sedentary life, all of which are provocative of a certain

laxity of tissue and want of resistance in the investing membranes, which finds its expression in the eye, in a distention which is, in fact, myopia." (Loring.)

It is extremely important to see wherein the school and its occupations may act as a cause of near-sight, and what precautions can be taken against this result.

It is evident that the entire physical condition of the pupil is connected with the question of near-sight. Depressed general health, headache, narcosis from animal or mineral poison, excessive heat upon the head, or cold about the feet, contribute in various ways to weaken the power of the organ temporarily. Employed for study under such conditions of depression, it will naturally be held closer than usual to the book; and the result is, in many cases, the formation of a habit of reading with the eyes too near the object—a habit tending to cause myopia. An imperfect light, or a bad position relative to the light, compels the scholar to hold the book too close to his face, with the same result. Long effort fatigues the eye, as it does any other organ, and supplies another inducement to looking closely.

All that has been said above is confirmatory of the principle, too seldom considered by those concerned, that *a near-sighted eye is a diseased eye.* The talk about "near-sighted eyes being strong" is false and harmful. The disease is as disabling, in many cases, as a club-foot; it is as real a deformity as a crooked spine. It cannot be fully remedied by glasses. It excludes men from a great many positions in active life, and lessens in women the quickness in perception, which is their special gift and reliance. It is in a great many cases progressive.

The question of the production of near-sight in schools is one of great national importance. It is of the greatest consequence to know whether the English-speaking nations in general are destined to become near-sighted. The words of Dr. Loring [1] may well be quoted here:

"Are we in a position to declare, in the words of Ribot, with which we began these remarks, that 'since constant study creates myopia, and heredity most frequently perpetuates it, the number of short-sighted persons must *necessarily* increase in a nation devoted to intellectual pursuits'? This question can, at least at the present time, be answered only conditionally; and that is, that if, by a nation devoted to intellectual pursuits, we mean that compulsory education shall be carried out in the full extent of its original meaning, and applied to every child that is born, be it male or female, then I think the answer should be in the affirmative; and if Germany is going to be taken as the type, and every other nation desirous of intellectual progress be compelled to follow her lead as an example, then I am of the opinion that not only the educated classes, as the term is commonly understood at present, but that the world at large, will in time become near-sighted."

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[1] From a paper read before the American Social Science Association, and the County Medical Society of New York, 1877.

Dr. Loring's views are original, and appear so important that a summary is here given. At the present moment 62 per cent. of those who graduate from the public schools of Germany are near-sighted. American children are *not yet* in so unfortunate a condition, but the ratio of increase in the Americans is higher; that is to say, the ratio of 3.5 to 26.5 per cent., that in Germany being 11 to 62 per cent. The question appears to come to this: is not the difference one of degree rather than of kind, and will not the American youth in a few generations reach or pass the amount of near-sightedness which the Germans display if they adopt the same method of education and exact the same application of the eyes? In reply to this, he observes that there is an important element in the American character which is wanting in the German.

"Unlike the Germans, we have a fondness for out-door games as passionate almost as the English, and which we carry on with an ever-increasing devotion, in spite of the rigors of a winter which is almost arctic and a summer which is truly torrid. Side by side in our upper schools, at least for boys, are two classes—one that devotes itself principally, if not exclusively, to studious occupations, and one whose attention is turned chiefly, if not entirely, to athletic exercises; and, if the truth were known, I believe the conviction is growing in the mind of the community, if not in that of the professors themselves, that as great a benefit is accruing, and will accrue, to the race from the training in one class as the other.

"Now, whether this devotion to athletic exercises, with its accompanying reduction in the amount of study performed by a considerable part of the community, together with a better understanding and enforcement of hygienic laws, will suffice to prevent an increase in the amount of near-sightedness, can only be told by future examinations made at long intervals. But my own belief is, that we have, in the example of other nations, sufficient evidence to show the danger which threatens us, even if the evil is not actually upon us—evidence which should open our eyes to the fact that the amount of school work consistent with a healthy condition of the eyes has not only reached its farthest possible limit, but, in many places, far exceeds it; and that, instead of waiting to see whether or not the amount of near-sightedness will increase, we should, while there is yet time, take every means of lessening the quantity which now exists. The only question is as to how this shall be done. It would be answered at once that, as increased study produces myopia, the simplest way to reduce the amount would be to reduce the work. As a physician, I should, of course, personally approve of such a plan; but I fear it would meet with a strong opposition just where it would be the least expected—that is, from the parents of the children. Fortunately, this opposition is the less harmful, since I believe that the amount of myopia might be lessened without reducing the gross amount of application of the eyes, though it would materially change the time of life at which it was made.

"This belief rests on a fact which is, I think, the most important to which your attention could possibly be called in this connection—that is,

that near-sightedness is essentially a disease of childhood, or, at latest, of adolescent life. Thus Donders declares that he never has seen a case of myopia originate after the twentieth year; and Professor Erismann states that in his experience it rarely, if ever, began after the fifteenth or sixteenth year.

"It cannot be doubted that these statements are in the main correct, and in accordance with the experience of every observant oculist.

"The great period for the development of myopia, that is, for its *beginning*, is from the tenth to the fifteenth year—just at the time when the body, as a whole, is developing most rapidly. The investing membrane of the eye, which is elastic at this period of life, yields to the pressure of the watery contents of the eyeball, which is increased by continued application; and the result is a lengthening of the eye, which, as I have so often explained to you, is near-sightedness. What is more, this distention will take place under an amount of application during the years of early youth which, at a little later period, would not only produce no effect, but which might be increased manifold with impunity. After the eighteenth, or even sixteenth year, when the investing membrane of the eye has become firm and unyielding, over-study may produce other and graver diseases of the eye, but it will not produce near-sightedness. From this it follows directly that the simplest, indeed the only, method of preventing an increase in near-sightedness, if the present high standard of instruction is to be preserved in force, is to lessen the amount of work done by school-children during the period of life from eight to sixteen years, and to restore the equilibrium, if necessary, by increasing the amount of study after that time, or, better still, by increasing the period of time devoted to study. It is by complying with these conditions, whether consciously or unconsciously, that the English have become so eminently a literary people, and still, as a people, so free from myopia; while, on the other hand, it is the violation of these laws and their teachings, that is, by compelling the young of both sexes to undergo a large amount of study at a tender age, which has made Germany, without doubt, the shortest-sighted nation in the world. . . .

"I believe that the principal reason why the members of mechanical arts show less myopia than those of studious and literary occupations is not because they use their eyes less, but that the application of the eyes occurs at a different time of life, and under entirely different surroundings or conditions of existence. Until very recently the early education of apprentices in skilled labor was, fortunately, I think, for them, neglected. They had but little school learning. They did not even approach the niceties of their calling until they were sixteen or seventeen years of age, and oftener not until they were grown men; and even then it was in the most gradual and careful manner. Moreover, the work was often interrupted, often beguiled by conversation, either connected with, or absolutely remote from, their labor. When the apprenticeship was completed, and they came to close application of the eyes on near work, the dangerous period for the development of near-sightedness was over.

This is precisely the reverse of what takes place with the young student, whose hardest tasks often come just at a time when he is least able to bear them.

"If, now, in the light of what has just been laid down, the question is repeated, it might be answered, I think, with assurance, that there is no danger that the 'cultivated classes' will become near-sighted, provided that, while devoting themselves to literary pursuits, they are willing to recognize and abide by the few simple laws which have just been dwelt upon. On the contrary, I think there is every reason to believe that, with a little care and caution during the short but important period of life just alluded to, the present standard or normal eye, formed and perfected in the remotest past, may be continued indefinitely.

"Two questions have presented themselves to my mind while making my investigations on near-sightedness in the public schools. One is, whether the word 'instruction' is always synonymous with 'education;' and the second is, whether, while we are reducing the number of the absolutely blind in our asylums, by improved methods of operation and treatment, we are not, by over-use of the eyes at school, laying up a future evil which, though milder in form, will, from its very frequency, entail a greater and more lasting detriment upon the race."

Rules for the Care of the Eyes, especially in Children.[1]

When writing, reading, drawing, sewing, etc., always take care that—

(*a.*) The room is comfortably cool, and the feet warm;

(*b.*) There is nothing tight about the neck;

(*c.*) There is plenty of light, without dazzling the eyes;

(*d.*) The sun does not shine directly on the object you are at work upon, or upon objects in front of you;

(*e.*) The light does not come from in front; it is best when it comes over the left shoulder;

(*f.*) The head is not bent very much over the work;

(*g.*) The page is nearly perpendicular to the line of sight; that is, that the eye is nearly opposite the middle of the page, for an object held slanting is not seen so clearly;

(*h.*) That the page or other object is not less than fifteen inches from the eye.

In any case, when the eyes have any defect, avoid fine needlework, drawing of fine maps, and all such work, except for very short tasks, not exceeding half an hour each, and in the morning.

Never study or write before breakfast by candle-light.

Do not lie down when reading.

If your eyes are aching from firelight, from looking at the snow, from overwork, or other causes, a pair of colored glasses may be advised, to be used for a while. Light blue or grayish blue or a light smoke-color is the best shade; but these glasses are likely to be abused, and usually are not to be worn, except under medical advice. Almost all those persons who continue to wear colored glasses, having perhaps first received advice to wear them from medical men, would be better without them. Travelling venders of spectacles are not to be trusted: their wares are apt to be rec-

[1] From a contribution by the author, in the American Journal of Social Science, No. VIII.

ommended as ignorantly and indiscriminately as in the times of the "Vicar of Wakefield."

If you have to hold the pages of "Harper's Magazine" nearer than fifteen inches in order to read it easily, it is probable that you are quite near-sighted, or possess imperfect vision. If you have to hold it two or three feet away before you see easily, you are probably far-sighted or over-sighted, hypermetropic; meaning by each of these terms a condition in which the range of perfect vision is more distant than normal from the eye. In either case, it is very desirable to consult a physician before getting a pair of glasses, for a *misfit* may permanently injure your eyes.

Never play tricks with the eyes, as squinting or rolling them.

The eyes are often troublesome when the stomach is out of order.

Avoid reading or sewing by twilight, or when debilitated by recent illness, especially fever.[1]

Every seamstress ought to have a cutting-out table, to place her work on such a plane with reference to the line of vision as to make it possible to exercise a close scrutiny without bending the head or the figure much forward.

Usually, except for aged persons or chronic invalids, the winter temperature in work-rooms ought not to exceed 60° or 65°. To sit with impunity in a room at a lower temperature, some added clothing will be necessary. The feet of a student or seamstress should be kept comfortably warm while tasks are being done. In winter the temperature of the lower part of the room is apt to be 10° or 15° lower than that of the upper—a condition which implies improper arrangements for heating.

It is indispensable, in all forms of labor requiring the exercise of vision on minute objects, that the worker should rise from his task now and then, take a few deep inspirations with closed mouth, stretch the frame out into the most erect posture, throw the arms backward and forward, and, if possible, step to a window or into the open air, if only for a moment. All this presupposes good health and discretion. Two desks or tables in a room are valuable for a student—one to stand at, the other to sit at.

A few remarks upon the lighting of rooms are here in place.[2]

The walls may be colored a light green or a neutral gray;[3] the ceiling had better be white, as reflecting more and purer light. No paper is admissible; it is commonly a mere refuge of sluttishness. Blackboards ought not to be placed between or next to windows, for the simple reason that it is hard to read when facing a strong light. There will be three sides of the room, or in any case two, for blackboards, under the proper plan. The sides of the room are wainscoted up to the level of the blackboards; in the entries the wainscoting may properly be carried to four feet and a half for reasons of cleanliness.

The windows ought to open directly upon the outer air. No room for study is properly lighted otherwise. A transom window is to be placed over each door. To protect from excess of light, inside folding-blinds with rolling slats are very satisfactory; they throw the light up or down at option, and they admit fresh air in summer without noise, while curtains are likely to get injured in a high wind.

It is perfectly feasible to get an abundance of light, if care be taken. But the requirements made by sanitary science in this respect are very strict. Fortunately they can be fulfilled without great expense. An

[1] Or, in the case of women, by childbirth.

[2] From a paper by the author in the Sanitarian, November, 1876.

[3] Paint, whitewash, or hard-finish is good.

ordinary dwelling-room cannot usually be considered adequately lighted for school purposes. For ordinary uses it is sufficient for the occupant to move his work near a window when he has a difficult bit to do; but a scholar must have a perfect light, wherever in the room he sits. The requisites to this end are as follows:

a. The sill had better be placed four feet above the floor. Light entering at the level of the eyes only dazzles, and is almost useless for illuminating the tops of desks. Make the interior of the room pleasant, and the scholars will not want to look out at the window.

b. The top of the window must come as near as possible to the ceiling. By using iron girders we can bring it within eight inches of the latter, and this should be required. The reason for this requisition is, that the most useful light for a scholar's purpose is that which strikes his desk at something near a right-angle. This is furnished—first, by the upper part of the windows; and, second, by the ceiling: hence the propriety of using every means to secure the thorough illumination of the latter—a point which is neglected in most dwelling-houses, churches, and schools. Evidently the heads of the windows must be square, and not rounded or pointed, as is the case in certain picturesque styles of architecture. Neither is a pier of masonry dividing a window desirable. The roof must not project so as to cut off any appreciable light, nor are verandas at all allowable in the quarter whence light is supplied. There must be no wing or production, no pier or column, in the way of light. These restrictions set a limit to the indulgence of the architect's taste; but they leave room enough within the limit. If projections are forbidden, flat decoration and ornamental brick-work are admitted; and shafts, wide doors, groups of windows, are features which can be seized upon to give a characteristic style to the building, which need be neither ecclesiastical, Hellenic, nor commercial.

c. The proper position of the windows is tolerably well settled. No window should be placed in front of the scholar; for the light thus entering is worse than wasted, blinding him at work, and tending directly to produce near-sight. Windows on the right are slightly objectionable, as throwing a shadow on the page whenever the hand is used in ciphering, drawing, or writing. Windows at the back throw the pupil's own shadow on his book; but this is not a serious matter except for those who sit next a window, and they have light enough at any rate; while for writing they are extremely well placed, as it is usual to turn partly to the left in this exercise. Windows at the left are entirely free from objection, as far as they can be free. The ideal light should come from over the left shoulder, or the right shoulder, if one is sitting up and reading; but, if looking over a desk, this is rather inconvenient, and the best is then a very high light from the left and a little in front. In brief, the rule for placing windows is: *never* in front, *always* on the left; at the back also, if you choose, but not at the right, if you can help it. Light from the left and the back at once does not harm the eye, and practically is quite admissible; the only person to find fault is the teacher, in whose eyes

the light will fall directly. These principles commend themselves to common sense, and are in accordance with the highest medical authority in this country. The German authorities agree substantially with what I have said, though they differ among each other in the degree of emphasis with which they forbid the rear and right-hand windows. English schools are peculiar; and, from the shape of the rooms and the presence of galleries, are often hard to light.

The size of the windows, taken collectively, should equal at least one-sixth of the floor-space. Cohn requires one-fifth, or 30 inches to the foot. Less than this will probably be insufficient in many cases. It is also stated by the highest authorities in school hygiene that 300 or 350 square inches of glass are required for each pupil, and this requirement is nearly coincident with Cohn's in the German school-rooms. In ours, with their greater depth, it would not be nearly enough.

A clear and succinct statement of what a "model school-room" should be is made by Erismann,[1] which, as representing the present state of opinion in Germany, is given here in outline.

The length of this model room should not exceed 12 metres at the very extreme. Varrentrapp, Zwez, and others limit it to 9 or 10. This is determined by the visibility of objects at the distance of 9 m. Snellen's test-types, 3 ctm. in height, under the most favorable circumstances, are read by the normal eye at that distance: letters written on the blackboard, of twice that length ($2\frac{2}{5}$ inches), may probably be read with the same ease.

The depth of 7 m. should not be exceeded, as light does not penetrate with full effect beyond that distance. The proportion of length to breadth would then be = 10 : 7; nearly = 3 : 2. The floor-space is 70 sq. m.,—about 754 square feet.

The height should be not less than 4 m., or 13 feet. If over $4\frac{1}{2}$ m., it gives rise to an echo. The corners should be rounded to prevent the latter fault.

The cubic space in such a room being from 280 to 315 c.m., and as each scholar requires 6 or 7 c.m. of space (210 to 245 cubic feet), the number of scholars in the room may be from 40 to 48, and no more, supposing the air to be changed two or three times an hour. He mentions 20 c.m. of fresh air per head and hour as the quantity that ought to be supplied by artificial means, not taking into account the natural ventilation. This amount, 700 cubic feet, is very much less than that which is theoretically needed (3,500 cubic feet); but he insists on the necessity of frequently opening the windows wide in intervals of work.

The light must be taken from the left side only. A room which cannot be sufficiently lighted from that side is unfit for a school-room. The light is all the better when the windows are closely grouped and not distributed along the wall. The sill should slope inward, and its higher edge should be 1.1 or 1.2 metres above the floor—a little over 40 inches.

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[1] Vierteljahrsschrift für öffentliche Gesundheitspflege, 1876.

School Desks and Seats.

Two classes of children require special favor, or special arrangement, in the assignment of seats. The near-sighted and those partially deaf ought to sit near the teacher; and any custom of seating pupils by rank should give way before this medical necessity. It is extremely desirable that such children should be examined by suitably qualified physicians. In the case of the eye, both the nature and extent of the disease are easily mistaken by an unprofessional observer; and the use and selection of glasses ought always to be directed by a physician. In the case of the ear, a great part of existing disease in children is curable, or at least may be improved, and is nearly certain to grow worse by neglect.

Badly proportioned desks and seats may aggravate the tendency to near-sight, by compelling the scholar to lean forward too far in writing or reading, or by bringing the page too near the face.

The natural and correct position for a book is a more or less upright one. If a book lies flat, the reader has to stoop somewhat. Most desks are sloped a little, to satisfy this requisition, and for most children this may answer; but a near-sighted child ought to have a desk at which he can sit upright, and face the book, which should be raised at a considerable angle, say about 60° from the horizontal. Such a desk has the lid in two pieces, hinged together, and the piece next the body can be tilted up to the required angle, like the music-holder of a piano. Fifteen inches is a proper distance to hold the object looked at.

As desks have been mentioned, it may be best to complete the notice of certain essential points in their construction.

The seat, if too high, raises the feet from the floor, and deprives the body of two important points of support. The feet should rest firmly on the ground or on a foot-board, the knees not elevated.

The child sitting upright on the seat, and his arms hanging freely, the edge of the desk next his body should be about one inch higher than the level of his elbows. If the desk be higher than this, it will cause a tendency to twist the body in writing; one shoulder will be raised more than the other, and lateral curvature of the spine may be the result. In parts of Germany and Switzerland such deformities have been observed in great frequency among scholars using such desks. For girls the desk may be one-half or three-quarters of an inch higher.

A line dropped from the edge of the desk ought not to fall clear of the seat, but should strike the edge of the latter or an inch or two within it. This arrangement brings the desk so near the body that the child naturally takes an upright position, and is not able to lean over in writing, as is the case when the seat is at some distance from the desk. This upright position should be maintained in the interest both of the eyes and of the spine.

As a general rule, American school-desks and seats satisfy these requirements pretty well. They almost invariably have supports for the

shoulders, which is not thought necessary by some careful students of the subject in Germany, a support rising a trifle above the level of the elbow being thought sufficient.

There is, however, one point which is greatly neglected. In a large room, containing fifty or sixty seats and desks, it is quite usual to find all of one size, so that only a portion of the scholars are suited. The most perfect grading of schools will not prevent considerable inequalities in the size of the scholars in each room; to meet which *three* sizes of desk ought to be employed for each class in large graded schools. In schools of mixed ages, the number of sizes must be increased.

DIMENSIONS (IN CENTIMETRES) OF SCHOOL DESKS AND SEATS SUITABLE FOR SCHOLARS OF DIFFERENT SIZES.

	Height of the scholar.	Height of front edge of desk above the seat.	Height of back edge of desk above the seat.	Height of seat from floor (or foot-rest).	"Difference."[1]	"Distance."[2]	Height of upper edge of back of seat, from seat.	Distance of back of seat from back edge of desk.	Breadth of back of seat.	Depth of shelf for books.	Perpendicular distance of shelf below the desk-lid.	Depth of seat.
I.......	98–109	51.5	45.5	30.	15.5	–5	15.5	17.5	8	20	10	22.5
II.......	109–120	56.	50.	33.	17.	–5	17.	19.	8	20	10	24.
III......	120–131	60.	54.	36.5	18.5	–5	18.5	20.5	8	20	10	25.5
IV......	131–142	66.	60.	40.	20.	–5	20.	22.	8	22	10	27.
V.......	142–153	71.5	65.5	44.	21.5	–5	21.5	23.5	8	22	12	28.5
VI......	153–164	76.5	70.5	47.5	23.	–5	23.	25.	8	22	12	30.
VII.....	164–175	81.5	75.5	51.	24.5	–5	24.5	26.5	8	24	12	31.5
VIII....	over 175	86.	80.	54.	26.	–5	26.	28.	8	24	12	33.

[1] The term "difference" = difference between height of seat and height of desk, at the part next the scholar.

[2] The term "distance" in the table denotes the distance between this perpendicular line* and the edge of the seat. (* See bottom of p. 614.)

Mental Application.

To a child in good health there is nothing more delightful than the properly-directed use of his mental faculties. I need not stop to argue the advantages of the kindergarten; but, assuming them, I would point out how earnest, how interested, how pleased the children are with a process involving so much real exertion of mind that they are not allowed to give more than two and a half or three hours a day to it. Beyond all question, the bodily and mental health of children is promoted by a process which is thus conducted and restricted. Mental labor, rightly directed, is a most healthful occupation; and there is no real reason why this should not be true at all periods of school-life. The interest of little children can be kept up to any desirable pitch by methods which have been reduced to a system: if this is not true of older scholars, is it not because the key has been lost by their educators?

All plans of study which force children to assume a task before the mind is sufficiently developed to grasp it are bad; and so are all which

compel the child to learn without understanding what he is old enough to understand. Some children are averse to reflection, or are gifted with such ready memories that they find it much easier to learn by rote, without making the effort to understand. But I think there are few to whom their studies cannot be made attractive by rational means of teaching; so that the effort is made spontaneously, instead of by compulsion. And the difference between spontaneous and forced action is of great consequence to the health and mental energy of the child.

It is bad to suppress the natural working of a pupil's thought in connection with his study. This suppression may be effected by neglect, by oversight, by want of sympathy, on the part of a teacher; and when a teacher is herself overworked, and forced to attend to an excessive number of pupils, who remain with her for a very short time, she may be free from blame for such neglect. It may also be effected by a routine of study which exacts visible and measurable results—a given number of pages or of "facts" acquired, rather than comprehended—a routine which can be and is successfully passed through by scholars only by bending all effort to the act of acquisition. A scholar may not be conscious of it, and may be trying faithfully to do his duty; but, if his mind is not properly fed by his school and his teacher, he will show signs of inanition. Food eaten with an appetite is the better digested; and mental dyspepsia is not good for the bodily health.

A more obvious source of bodily or mental injury exists in the overwork and strain which, there is reason to fear, fall upon numbers of our children. By overwork, I mean an absolute excess of exertion; by strain, working at moments of fatigue, or working under excess of emotion. I will speak of these in turn.

1. *Amount of mental exertion.*—It is true that individuals differ widely in their capacity for effort; nevertheless, among the very great majority of educated persons and children in school there is a tolerable degree of uniformity.

At West Point Military Academy everything is in favor of the utmost efficiency. The pupils are picked young men, just past boyhood. They are excluded from dissipation and from general society; and their active bodily exercises, their regular diet and sleep, and the healthful climate of the place, leave nothing to be desired. The daily time assigned at West Point to study and recitations is about ten hours a day during the six cold months.

At the Massachusetts Agricultural College the actual work amounts to nearly ten hours daily, besides six and one-fourth hours of military drill and farm-work weekly.

These figures represent the maximum average capacity of a superior class of young men, free from disabilities, at their most vigorous age.

In universities, probably a somewhat lower average might be found. As far as my own inquiries extend, the amount of study and recitation which is most profitable varies between eight and nine hours a day.

In high-schools, during the period of rapid growth and sexual development, a lower figure must be assumed; and it seems certain that five hours, or, under the most favorable circumstances, six, is all that should be required. The age of pupils in high-schools usually ranges from 12 to 17.

Below the age of 12 years, four hours are probably sufficient; below 10 years, three or three and a half; below 7 years, two and a half or three. In regard to children under 10 years of age, my opinion is strongly in favor of this restriction. The arrangement by which these young pupils are kept in school the same number of hours as those of the age of seventeen is absurd from every point of view except one. That one is, however, the one taken by a majority of parents, who consider that they pay to have their children *taken out of their way* for a given number of hours, and are annoyed by their presence at home. Every attempt to cut down the hours of attendance for young children will be met by prejudices based upon this belief.

It is one of the best established laws of physiology that work in excess of the power of the system adds nothing to the result achieved. If a child's capacity is limited to three hours' work, then he will in the long-run accomplish no more by being held down to five hours' work a day. Experience proves this abundantly. Economy in the use of public money demands that it be recognized. If a fact, it ought to occupy a foremost place in the plans for improvement which our school boards are supposed to entertain. It is therefore proper to state some of the grounds upon which the above statement of the number of hours suitable for children's study is based.

The argument *a priori* is complete. Children are characterized by imperfectly developed brains, by a feeble power of concentration, by inability to perform continued tasks of any sort without injury. Their bodies and their minds alike require frequent change of position. It is true that in a child of eight years the mental faculties are employed upon some object or other, and often with earnestness and concentration, for at least twelve hours of each day. But it need hardly be said that the child works very differently from the adult, and that *certain classes of work*, as the scholastic, cannot be performed by him in the same way. The solid results of mature scholarship are attained by the power of long-continued application, of which the child is destitute. A child of from 5 to 7 years is said to be able to attend to one subject, a single lesson, for about 15 minutes; from 7 to 10 years, about 20 minutes; from 10 to 12 years, about 25 minutes; from 12 to 16 or 18 years, about 30 minutes.[1] And the inference is justifiable, that a child's power of accomplishment, in mental effort, is represented by half as many hours' work daily as in the case of a young person of 15 years

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[1] This opinion is quoted from the work of Mr. Edwin Chadwick upon the Half-time System in Education—a work to which the reader is respectfully referred for a large body of facts bearing on this and cognate points.

The argument *a posteriori*, based on experiment, is apparently in favor of the same conclusion. For instances in which the half-time system has been tried, the reader may consult the Reports of the Massachusetts Bureau of Labor for 1871, 1875, and 1878, which contain carefully prepared accounts of that system. Without repeating here the statements collected in these papers, it may suffice to say that they should carry great weight as coming from practical men both in England and America.

As understood in England, the "half-time system" is a plan for educating children of the laboring classes by sending them to school for three hours each day, or thereabouts, and employing them in factories, in shops, or on farms, for the rest of the working hours. It is generally found in England that children thus employed make as good progress in study as those who attend school for six hours a day. About 100,000 children are thus taught; in America the plan is not now in use, I believe, but former experiments in several places have given favorable results.[1]

It is proper to observe that these arguments for shorter hours of study reach the same conclusion as that of Dr. Loring, above quoted. That the conclusion is drawn from entirely different premises is a fact which ought to confirm its value.

2. *Strain, or work performed at a disadvantage.*—In our schools all are expected to "toe the mark," or to accomplish the same stint of work. Those who for any reason, such as temporary indisposition, are unable to do this, are blamed or punished, and the unusual effort made by such scholars constitutes, in many cases, an injurious strain upon the faculties. In general, teachers are not to blame for this. They have no time to spare to help the slow ones, and are not generally permitted to make allowance for indisposition. It is not hard to see how a rigid system, or an overcrowded course of study, may act in discouraging and depressing a conscientious pupil. The teacher has no time to teach him; he must learn his lesson, or, at all events, must learn to recite, and, if unable to grasp the statements contained, he has the mortification of failure after doing his unaided best. Uniformity enforced on a large scale, an excessive number of pupils to a class, and an excessive number of studies, are so many elements in the production of this evil.

A system of rank and rewards based on success in reaching an arbitrary standard of acquirement is, no doubt, highly stimulating. For boys the stimulus is desirable, as a rule; for girls not. The mere amount of labor exacted of children is not so important as the spirit in which it is done; and, in the case of girls, the apprehension of failure, the dread of disgrace, the eagerness for success, are so much more acute than in boys, that they are easily injured by appeals to these emotions, which would be rather beneficial to boys. To enforce this point—the danger of

[1] In Salem, Mass., it is carried out to a limited extent, under special conditions, with success.

effort performed under stress of emotion in sensitive subjects—I will add the remark, that emotion is a far more active cause of insanity than any kind of over-exertion of body or mind.

In the case of girls there is a special occasion for slight relaxation of discipline or requirements during the period of the monthly illness. Neglect of this fact has injured the health of many thousands under our system of education. The growth of girls for two or three years, from the age of 11 or 12 onward, is very rapid; in fact, they then surpass boys of their own age, both in height and weight. With this rapid growth, and, with many, rather later than earlier in the period, there comes the development of the sexual functions—a critical event in the life of a girl. Bodily growth in this double sense, and the moral development which should go with it, form, during these years, the most important functions of her existence. It is then, however, that she is exposed to two sorts of strain most deleterious to her vitality, namely, the pressure to complete her education (which is supposed to be finished in all points at an age when boys are only prepared to enter college), and the pressure of outward life, of what is called "society." It is enough to point out these: the remedy must be left to the wisdom of those who frame systems of education and those who are the parents of girls.

Boys of a corresponding age need to be watched over, and advised or warned concerning a bad habit which is very common. A great deal of discretion is necessary in addressing them; but I believe that a plain, direct, serious statement, coming from a master who is respected for his own character, will arouse conscience in some, and will deter others from acts which are most often begun in ignorance of their nature and consequences. It is hard to see why parents neglect this duty; but, as it is neglected, the schoolmaster cannot avoid some part of the responsibility.

The health of teachers is more liable to fail under our present system than that of scholars. It is perhaps a sadder sight to see a young child's forces of mind exhausted by overwork; but the real loss to the community is greater when a fully-developed woman of cultivation and ability drops from a condition of perfect health and energy into invalidism, temporary or permanent. In the case of a large number of teachers the fatigue is so great that the two months of summer holidays are spent, as it were, upon a sofa, and properly so.

Several causes may be assigned for this exhaustion. In the first place, no doubt many teachers neglect the exercise which would keep them in health. It is fortunate when one lives at such a distance as to have to walk from four to six miles daily; a habit of exercise formed under these circumstances is invaluable. No doubt some eat too little through ignorance of what is needful, or take tea instead of beef, or go to bed hungry and cold, or neglect their noon meal, or hurry their breakfasts; some are weighed down with home cares; scarcely any probably injure themselves by "dissipation in society."

But besides all this there are several circumstances which lie entirely beyond their control, some or all of which are certainly the source of seri-

ous harm. The day's work, including the time spent in going to and from school, opening and closing the sessions, lasts from eight to five, with a sufficient intermission at noon. If thoroughly performed, such a day's work is enough for the average capacity of a healthy woman. It calls into vigorous play most of the faculties, and requires a good deal of muscular exertion in speaking. Responsibility is never absent, and annoying conflicts with obstinacy or stupidity are not unfrequent. At the end of a day a teacher should be free to rest and recreate herself until the next morning. This, however, is often not the case, and many have to spend several hours of the evening in looking over written exercises or in making up school statistics. Such an overplus of work is injurious, not simply because of its amount, but because it forces the mind to go back to the anxieties of the past day, and allows of no let-up from Monday morning to Friday night. Business men cannot stand such a course of life, nor can teachers. Who does not recall, in each of these classes, a number of instances of break-down due to a similar cause?

It is worthy of notice that the hardest work of the year comes at a season when teachers and pupils are least able to bear it. In the winter many work to the utmost of their strength, sustained by the stimulating climate: in spring this stimulus fails, appetite for food is lessened, and a certain languor is felt by many perfectly sound persons. It is then that the work of the year approaches its climax, and the entire school for two months is conscious of a moral spur to increased effort. The yearly examination at the close of June requires additional exertion in preparing papers, correcting, marking, averaging, and in making ready for a public exhibition.[1]

It is the duty of the medical profession to express an opinion as to the amount of labor which teachers can properly be expected to perform; and in connection with this, the number of scholars that can be attended to. A favorite number, in American schools, is fifty-six; which appears to the writer too large. By lessening the number of scholars, decidedly greater progress could be made with equal ease, and with better comprehension of the subjects taught.[2]

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[1] To a question put by the Massachusetts Board of Health, in 1872, in a circular addressed to correspondents—viz.: "Is Consumption ever caused by over-study at School or College?"—the following answers were sent: "Yes," from 146 correspondents; "Yes," indirectly, from 7; "No," from 21; "Doubtful," from 10. The editor of the paper, Prof. H. I. Bowditch, remarks: "I have seen not a few patients—scholars—who, under the violent stimulus put upon them by an approaching exhibition, or examination for rank or for prizes, have sunk immediately after such extra intellectual labor, wholly prostrated in mind and body; and where I have seen them, far-advanced consumption was plain. Such cases are utterly hopeless."

[2] The following letter from a teacher in a Boston public school will be of interest. It fairly represents the point of view, not of the sickly, but of the strong and able teacher.

"I think the work of most teachers extends from Monday morning at least to Saturday night. The many Saturday classes for teachers give mental work very different from that of the five school-days, but the school-care is present there.

"Bad ventilation is another chief source of illness, I think. Many colds come

The above remarks are applicable, in principle, to all classes, as well as to teachers and scholars. In modern adult life, the nervous system breaks down so frequently as to have compelled the invention of a new term, "neurasthenia" (described in Vol. XIII. of Ziemssen's Cyclopædia), which corresponds nearly, in the male sex, to what has long been known as "spinal irritation" in the female. These difficult, often almost hopeless cases, are usually the result of a double series of causes: first, hereditary tendency to nervous break-down; and second, excess of effort, or rather of strain, in adult life. Mere muscular excess is rarely the cause, in our times, though sometimes this seems to be the case. Anxiety and continued exertion are the chief causal factors of neurasthenia; and they will doubtless continue to be such, as long as "success" remains the absolute duty of every citizen.

It is very doubtful whether the American merchant accomplishes more by his constant activity than the Englishman does with his shorter hours and longer relaxation. There can be no doubt whatever of the ultimate effect. The amount of effort which can be safely exacted from a human being is exceeded by large numbers of our citizens, and the result must be degeneracy, in the parent and in the child.

This degeneracy does not usually take the form of an appreciable organic lesion, such as sclerosis, of the nerve-substance. The affections which it causes are rather such as imply a defect of nutrition (involving power or coördination) usually within the limits of apparent anatomical integrity.

The tendency to the production of organic degenerations of the blood-vessels, the kidneys, and other viscera, in the case of protracted close devotion to a monotonous business in a dull climate like that of England, is now well understood. In the beginning of many such cases a benefit, almost equivalent to a "renewal of life" may be expected from a total change of climate, with new and vivid mental interests, for at least six months.

The chief difficulty, in the case of many men, seems to consist in the impossibility of finding for them any relaxation: they have no interest except work, and are unfit for any work except of one sort—that which it is absolutely necessary that they should escape from for a time. The remedy for this mental helplessness may be found in the hands of the educator. When our youth are made to feel that music, botany, carving, and other things which may be taught, are objects worthy of the attention, not only of children and half-grown youths, but of men of business

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from the necessity of securing only partly purified air by means of a cold draught; and repeated colds, with no possible 'let-up' in the work meanwhile, are in part the cause of the spring break-down.

"Mr. Collar, of the Roxbury Latin School, told me once that he made it a rule for his teachers to lessen their own work and their pupils' when the warm weather begins. I try to do the same thing with my classes, and I know of others who do; but even where the endeavor is made, I think what you say of the culminating of school work when the system is least able to bear it is perfectly true."

and matrons, then a step will be taken which may lay the foundation of habits of relaxation, that will save many a mind from "break-down" or perhaps from insanity.

It is true to a large extent that the mind is more rested by a change of activity than by absolute repose. It is, however, essential, that, in thus changing, the mind shall not merely turn from a disagreeable task to an uninteresting one, but shall draw from the new pursuit the pleasure which novelty ought to give. The literary man may find great pleasure in entirely laying aside a subject for weeks, and turning to a new one. All of us require to see new places and persons; and this longing for change is so far from being inconsistent with steady habits that it constitutes one of the chief elements in the value of the Sabbath, considered physiologically.

Few men can stand more than five or six hours of original work per day; somewhat more of routine work may be borne, if performed under good conditions, in good air and light, with a mind free from anxiety, and a stomach that gives no trouble. A good many will not bear ten hours a day of mental routine work.

In the case of women, there is a phrase frequently used by them which suggests an etiology. Many women claim to possess "great nervous strength," with little physical endurance. The meaning of the expression is, that they are capable of an effort of will, sustained for years if need be, which gradually drains from them all the forces of their system. The effort may be made for ambitious reasons, as in the case of girls at school. Among adult women it is commonly made for unselfish ends—for the purpose of advancing the interests of husband or family, or of nursing an invalid through long illness. The result is, the production of a pitiable state of worthless invalidism.

It is proper to add that sexual irregularities and excesses form an important cause of nervous break-down; but the present is not the place to treat of them.

No subject deserves the more careful attention of physicians than that of the education of young women. In America, in thousands of schools, large numbers of this class are collected, from the ages of thirteen up to twenty, and even older, in public schools, where they are made to conform to the same inflexible routine as that which boys of the same age are subjected to. It is doubtless of great value, in a moral point of view, that a girl should be ambitious to be punctual in attendance. But the moral gain is outweighed by physical loss, if the scholar makes a practice of coming to school without her breakfast, for reasons of family convenience, as is very often the case.

It is desirable that she should feel the obligation to prepare her lessons; but in how few cases is that obligation tempered by an allowance for the modified state of feeling and force which attends the monthly periods! The principal of a high-school for girls, numbering nearly eight hundred, informs the writer that, upon entering upon the duties of his office, he found no recognition of this fact in the administration of the school; that

no "difference was made" for those who were unwell. With the aid of the first assistant teacher—a woman of rare sense—he divided the school into classes of thirty, assigning to each class one lady teacher, whom every girl was expected to inform of the occurrence of the monthly function, on each occasion, on entering school in the morning. As is usual in American schools, almost all the instructors are females. Each scholar, on thus notifying her matron (if the term may be used), is excused from going to the blackboard to stand for work; from standing in recitation; from going up and down stairs to recite in special studies, and especially from going down-stairs to work in the chemical laboratory. These rules commend themselves to the common-sense of the profession; for they have not yet penetrated the intelligence of the public. The principal of a high-school for girls and boys informs the writer that he had been accustomed to excuse the girls from a day or two of attendance upon their simple request, without compelling them to state the reason; but that the practice had been stopped by the remonstrance of a number of his school committee, who complained, in the presence of the boys and girls, of the low percentage of attendance of the latter. It is, however, now recognized by the more intelligent that school-houses for girls must not be built of more than two stories, if it can be avoided.

Bodily Exercise.

In country schools, there are opportunities for play which may make gymnastics unnecessary. In fact, for boys who will play, sport is the best. In cities, however, and manufacturing places, many boys and most girls will find their privileges of open-air sport curtailed; a fact to which is largely due the deterioration of modern civic populations. For these, gymnastics may replace the simpler discipline of rough-and-tumble sports, supplying a more thorough and systematic means of developing the body into usefulness and symmetry.

Some boys, and many girls, are so disinclined to active sport, or else so unhandy in it, that they need an artificial substitute. In the case of these, all arguments against the "unnaturalness" of gymnastics fade out of sight, when confronted with the fact that the system makes healthy and enduring adults out of weak and awkward boys and girls.

One of the chief advantages of gymnastics lies in the fact that they can be adapted to the needs of individuals better than other forms of exercise. This presupposes a teacher for gymnastics, a person capable of judging when a scholar should stop exercising, and so far instructed in the anatomy of the body as to recognize defects, and to apply the proper exercises for correcting them. Where there is no such guide, the teacher can adopt some form of calisthenics, which will be good as far as it goes; enough for many, and useful to all.

The lighter exercises, taken without apparatus, and without much movement of the legs, may be practised at a moment's notice at any time in the school-session. Their aim is not to make the muscles visibly bigger,

but to stimulate the circulation and respiration moderately, for a short time. They ought always to be so managed as to prove a diversion to the mind; in fact, this end is really the most important one connected with calisthenics. An easy tune may be played on the piano in concert with the rhythmic movements of the pupils. Marching, and various easy military manœuvers, are capable of interesting children. The teacher should aim to make the pupils feel that what is done is important ; and to this end she ought to know something of the first principles of physiology, and to feel their weight. If the children begin to look on the exercises as "silly," or the teacher considers them irksome, they are likely to be of small use.

A scholar should be expected to spend at least two hours out of every twenty-four in the open air, during most of the year. This requirement seems to me *moderate.* A teacher should spend at least an hour daily in the open air—not the air of a horse-car, or railroad.

The systems of gymnastics now in use—both heavy and light—are mostly the inventions of Germans or Swedes. There is one point in connection with the German practice which deserves our imitation : they place the apparatus in the open air, when possible, or in a shed separate from the schoolhouse, in the middle of a yard. The advantage of exercising in the open air is too obvious to need remark ; but the point is nevertheless very little attended to in our own public gymnasiums. Even school gymnasiums (where they exist) are not always well lighted and ventilated.

Singing constitutes an excellent exercise for the body, as well as relaxation for the mind ; but I have seen it carried on in a room set apart for the purpose, and so closely packed and badly ventilated that it was difficult to remain in it. It hardly needs to be said that that which sets the lungs in vigorous action implies and demands an abundant supply of fresh air; and that to perform exercise in close rooms is more exhausting than to sit still.

In institutions for young men and young women, some form of gymnastics ought not only to be encouraged, but, as shown by the accounts from Amherst College, Massachusetts,[1] it is feasible to require such exercise of all who are in health and free from deformity. The need of some vigorous muscular exertion is more felt by a certain class of young men who have always had some hard labor to perform; and who, on the other hand, have never acquired the art of elegant muscular exertion as an amusement.

[1] Report of State Board of Health, 1879.

BIBLIOGRAPHY.

Angerstein, Eduard: Theoretisches Handbuch für Turner. Halle, 1870.

Barlow, E. H.: Manual of Gymnastic Exercises, arranged on Hygienic Principles and adapted to Music. Amherst, Mass., 1866.

Barnard, Henry: School Architecture, or Contributions to the Improvement of School Houses in the United States. 6th edition. 1860.

Becker, Bernhard: Ein Wort über das Schulwesen mit besonderem Bezug auf körperliche Bildung. Basel, 1860, pp. 96.

Becker, Theodor: Luft und Bewegung zur Gesundheitspflege in den Schulen. 1867.

Bock: Ueber die Pflege der körperlichen und geistigen Gesundheit des Schulkindes. Leipzig, 1871.

Bock, E.: Zweckmässige Einrichtung der Schultische. 1868.

Bouchardat, A.: Le travail, son influence sur la santé. 1863.

Buchner: Zur Schulbankfrage. 1869.

Burn, R. S.: On the Arrangement, Construction, and Fittings of School-houses; compiled from the best authorities, with Original Notes and Designs. Edinburgh and London, 1856.

Chadwick, Edwin: Letter to N. W. Senior, explanatory of Communications and of Evidence on Half School-time Teaching; on the Military Drill, and Physical Training, etc. Education Commission of Great Britain. 1861.

Idem: Communications respecting Half-time and Military and Naval Drill. Education Commission. 1861.

Idem: Elementary Physical, and Mental Training. Journal of the Society of Arts, May 21, 1875.

Cohn, Hermann: Untersuchungen der Augen von 10,060 Schulkindern nebst Vorschlägen zur Verbesserung der den Augen nachtheiligen Schuleinrichtungen. Eine ätiologische Studie. Leipzig, 1867.

Idem: Die Augen der Schüler d. h. Friedrichs-Gymnasiums und ihre Veränderungen im Laufe von 1½ Jahren. Jahresbericht des Gymnasiums. Breslau, 1872.

Idem: Die Schulhäuser und Schultische auf der Wiener Weltausstellung. Breslau, 1873

Idem: Die kurzsichtigkeit unter den Schulkindern und ihre Beziehung zu Schultisch und Helligkeit der Schulzimmer. Nach Untersuchung von 7,568 Schülern. Deutsche Klinik, Feb., 1866.

Idem: Schulhäuser auf der Pariser Weltausstellung, vom hygienischen Standpunkte aus beurtheilt. Berlin, 1867.

Cohn: Refraktion der Augen von 240 atropinisirten Dorfschulkindern. Archiv f. Ophthalmologie. Vol. 17.

Conrad, Max: Refraktion von 3,036 Augen von Schulkindern u. s. w. (in Königsberg), mit 2 Tafeln. Leipzig, 1876.

Das Schulgebäude. Referat, auf Veranlassung von Anträgen mehrerer Gemeinden, abgefasst im Namen des Niederrhein. Vereins f. öffentl. Gesundheitspflege. Correspondenzblatt des Vereins, Nos. 7, 8, 9. 1875.

Dries, L.-F.: La gymnastique à l'école primaire, à l'école gardienne et au jardin des enfants. Musique de P. Depoerck. Ghent, 1873.

Eisenschütz: Die Schulhygiene auf der Weltausstellung in Wien. Wiener med. Wochenschrift, 1873, p. 909.

Emmert, Emil: Des troubles fonctionnels de l'œil humain en général et spécialement d'après les visites scolaires faites dans les cantons de Berne, Soleure et Neuchatel. Trad. de l'allemand. Berne, 1877.

Idem: Ueber Refraktions- und Accommodations-Verhältnisse des menschlichen

Auges, nach eigenen Untersuchungen. Bern, 1877. This contains the statistics of most of the examinations of eyes hitherto made, reduced to tabular form with great thoroughness.

Erismann, Friedrich: Das Project eines Musterschulzimmers, vorgelegt der hygienischen Commission des pädagogischen Museums in St. Petersburg. Deutsche Vierteljahrsschrift für öffentliche Gesundheitspflege, 1877, p. 546.

Idem: Ein Beitrag zur Entwicklungsgeschichte der Myopie, gestützt auf der Untersuchung der Augen von 4,358 Schülern und Schülerinnen (in St. Petersburg). Graefe's Archiv f. Ophthalmologie, 1871, Bd. 17, Abth. 1.

Fahrner: Das Kind und der Schultisch. Die schlechte Haltung der Kinder beim Schreiben und ihre Folgen, sowie die Mittel derselben in Schule und Haus abzuhelfen. Zürich, 1865.

Falk, Friedrich: Die sanitätspolizeiliche Ueberwachung höherer und niederer Schulen und ihre Aufgaben. Leipzig, 1868.

Frey, J.: Der rationelle Schultisch als das hauptsächlichste Verhütungsmittel der schlechten Brustentwicklung, der schlechten Haltung und der Rückgratsverkrümmung. Zürich, 1868.

Freygang, Gustav: Die Schule und die leiblichen Uebel der Schuljugend, ein zeitgemässes Wort an Eltern und Erzieher im Interesse des Staates, der Gemeinde und Familie. Leipzig, 1863.

Froriep, Robert: Bemerkungen über den Einfluss der Schulen auf die Gesundheit. Berlin, 1836.

Gaillard, R.: Hygiène des lycées, collèges, et des institutions de jeunes gens; composée d'après les documents les plus autorisés, etc. Paris, 1868.

Gast: Aerztliche Beiträge zur Reform des Volksschulwesens in Sachsen, mit specieller Berücksichtigung der Dresdener Schulen. Leipzig, 1863.

Gross: Ueber Ursachen und Verhütung der Kurzsichtigkeit und über Schuleinrichtungen. Würtemb. Correspondenzblatt, 1866.

Guillaume, L.: Die Gesundheitspflege in den Schulen. Aarau, 1865.

Idem: Hygiène des écoles, conditions architecturales et économiques. Paris, 1874.

Gerstenberg, Adolf: Die städtischen Schulbauten Berlins. Mit XV. Tafeln (large folio). Abdruck aus der Zeitschr. für Bauwesen. Berlin, 1871.

Häckermann, W.: Lehrbruch der Medicinalpolizei. Berlin, 1863.

Hermann, A.: Ueber die Einrichtung zweckmässiger Schultische, ein Beitrag zur Gesundheitspflege in den Schulen. Braunschweig, 1868.

Hitchcock, Edward: The Department of Physical Education and Hygiene in Amherst College. Tenth Report, Mass. Board of Health, 1879.

Hofmann, A.: Beobachtungen und Erfahrungen auf dem Gebiete der Schulgesundheitspflege, mit brieflichen Gutachten über Luftheizung u. s. w., von Freih. J. v. Liebig u. A. 1874.

Hoffmann: Augenuntersuchung in 4 Wiesbadener Schulen. Klinische Monatsblätter für Augenheilkunde. 1873.

Jaeger, O H.: Die Gymnastik der Hellenen in ihrem Einfluss auf's gesammte Alterthum und ihrer Bedeutung für die deutsche Gegenwart. Gekrönte Preisschrift. Esslingen, 1857.

Junod and Senglet, professeurs de gymnastique: Gymnastique populaire raisonnée à l'usage des écoles primaires, secondaires et supérieures ainsi que pour tous les âges. Paris et Neuchatel, 1873.

Jolly, William: Physical Education and Hygiene in Schools. Read at the British Association, September, 1876. London.

Idem: Physical Education for Common Schools. Proceedings of the National Association for the Promotion of Social Science. 1875.

Kedzie, R. C.: School Buildings, in relation to their Construction, Warming, and Ventilation, etc. First Annual Report of Michigan Board of Health. 1873.

Klencke, Hermann: Schul-Diätetik. Praktische Gesundheitspflege in Schulen und Gesundheitslehre für Knaben und Mädchen in der Schulzeit. Leipzig, 1871.

Kleiber, C.: Gelegentliche Gedanken über Schulbauten und die Einrichtung von Schulzimmern; im Programm der Dorotheenstädtischen Realschule zu Berlin. Berlin, 1866.

Idem: Der Nachmittagsunterricht und das Schullocal; in demselben Programm. 1867.

Kloss, Moritz: Die weibliche Turnkunst. Zweite Auflage. Leipzig, 1867.

Kuby: Das Volksschulhaus, mit besonderer Berücksichtigung der Verhältnisse auf dem Lande und in kleinen Städten. 14 Tafeln. Augsburg, 1875.

Kuby: Die Schul-Hygiene auf der Internationellen Ausstellung für Gesundheitspflege und Rettungswesen zu Brüssel im Jahre 1876, nebst Bemerkungen über den gegenwärtigen Stand der Subsellienfrage. Deutsche Vierteljahrsschrift f. öffentliche Gesundheitspflege, 1877, p. 396.

Krause, Otto: Der Luftwechsel in den Lehrzimmern der Annaberg-Buchholzer Schulen und des kgl. Seminars zu Zschopau. Ein Beitrag zur Beurtheilung der Heizungs- und Ventilationsanlagen in Schulgebäuden. 1874.

Krüger: Untersuchung der Augen der Schüler des Frankfurter Gymnasiums (203 an der Zahl). Jahresber. über die Leistungen u. Fortschritte der Ophthalmologie. 1873.

Lang, C.: Erfordernisse eines zweckmässigen Schulgebäudes und der dazu gehörigen Räume. Braunschweig. 1862.

Laprade, Victor de: L'éducation homicide, plaidoyer pour l'enfance. Paris, 1868.

Lincoln, D. F.: In Journal of the American Social Science Association, No. VIII. Report of Mass. Board of Health, 1878; Report of Mass. Board of Education, 1879.

Ling, P. H.: Gymnastic Free Exercises of; arranged by H. Rothstein. Translated, with additions, by M. Roth. London, 1855. Also, a broadsheet containing a Few of the Exercises illustrated.

Lion, J. C.: Statistik des Schulturnens in Deutschland. Leipzig, 1873.

Loring, E. G.: Is the Human Eye changing its Form under the Influence of Modern Education? New York, 1878.

Lorinser, C. J.: Zum Schutz der Gesundheit in den Schulen. Berlin, 1836.

Martin, A. C.: The Ventilation of School-houses. Second Annual Report of the Massachusetts Board of Health. 1871.

Mason, Samuel W.: Manual of Gymnastic Exercises for Schools and Families. Boston, 1863.

Meyer, Herm.: Ueber de wechselnde Lage des Schwerpunktes, die Mechanik der Skoliose und die Mechanik des Sitzens. Virchow's Archiv, Bd. 35, p. 225.

Idem: Bd. 38, p. 15.

Miller, Joh.: Die Schulhäuser und ihre Bewohner. Henke's Zeitschr. f. Staatsarzneikunde. 1842.

Monfalcon, J. B., and de Polinière: Traité de la salubrité dans les grandes villes. Paris, 1846.

Narjoux, Félix: Les écoles publiques en France et en Angleterre: construction et installation — documents officiels—services extérieurs — services intérieurs — salles d'asile—mobilier scolaire—services annexes. Paris, 1877.

Neigebauer, Joh. Ferd.: Das Volksschulwesen in dem preussischen Staate. Eine Zusammenstellung der Verordnungen, welche den Elementarunterricht der Jugend betreffen. Berlin, 1834.

Neuer Leitfaden für den Turnunterricht in den preussischen Volksschulen. 2te erweiterte Auflage. Mit 53 Figuren. (Official guide.) Berlin, 1868.

Nichols, A. H.: School-children and Dangerous Communicable diseases. Boston Med. and Surg. Journal, March 23, 1876.

Niemeyer, P.: Die Sonntagsruhe vom Standpunkte der Gesundheitspflege. Berlin, 1876. Reviewed in Deutsche Vierteljahrsschrift f. öff. Gesundheitspflege, 1877, p. 546.

Nycander, Ca. Ma. : Gymnastique rationnelle suédoise. Paris, 1874.

Ott, A., and Ritzmann, E. : Bericht über die Untersuchung der Augen der Gymnasiasten zu Schaffhausen. Schweiz. Correspondenzblatt, 1874, pp. 321–326.

Pappenheim, Eugen : Die Schule und die Gesundheit der Schüler. Pappenheim's Monatsschr. f. exacte Forschung auf dem Gebiet der Sanitätspolizei, 1860.

Pappenheim, L. : "Schulwesen," in his Handbuch der Sanitätspolizei.

Parow : Ueber die Nothwendigkeit einer Reform der Schultische. Berliner Schulzeitung, 1856.

Passavant, Gustav : Ueber Schulunterricht vom ärztlichen Standpunkte. Frankfurt a. M., 1863.

Pettenkofer : Ueber Luft in den Schulen, und über Ermittelung der Grenze zwischen guter und schlechter Zimmerluft. Pappenheim's Monatsschrift, 1862.

Pflüger : Untersuchung der Augen von 259 Lehrern. Monatsblätter für Augenheilkunde, 1875.

Philadelphia Board of Public Education : Report of Committee on Health of Schools. 1875.

Putnam, J. J. : Paper on Gymnastics, in Proceedings of American Social Science Association, Vol. VIII.

Reclam, Carl : Gesundheitslehre für Schulen. Leipzig u. Heidelberg, 1865.

Idem : Ueber Schulhygiene in Bau, Stube und Garten, mit Rücksicht auf das in Wien Ausgestellte. Anhang zu dem Protokolle des Sächsischen Ingenieur- und Architekten-Vereins, 81. ord. Hauptversammlung, December, 1873. Dresden, 1874.

Reuss : Die Augen der Schülerinnen des Communal-Realgymnasiums in der Leopoldstadt. Jahresb. d. Gymnasiums, 1874.

Reuss : Ueber die Schulbankfrage. Wiener med. Presse, 1874.

Riant, A. : Hygiène scolaire, avec 42 figures. Paris, 1874.

Robson, Edward Robert : School Architecture. Being Practical Remarks on the Planning, Designing, Building, and Furnishing of School-houses. With more than 300 illustrations. London, 1874.

Roth, M. : Handbook of the Movement Cure. 1856.

Id. : Prevention of Spinal Deformities. 1861.

Scheiding : Resultate der Augen der Schüler am Gymnasium zu Erlangen. Inaug.-Diss., 1876.

Schildbach, C. H. : Die Schulbankfrage und die Kunze'sche Schulbank. 2te Aufl. Leipzig, 1872.

Schreber, D. G. M. : Ein ärztlicher Blick in das Schulwesen in der Absicht zu heilen und nicht zu verletzen. Leipzig, 1858.

Idem : Die shädlichen Körperhaltungen und Gewohnheiten der Kinder. Leipzig, 1853.

Idem : Aerztliche Zimmergymnastik. Leipzig, 1872.

Idem : Kallipädie, oder Erziehung zur Schönheit. Leipzig, 1858.

Schraube, Otto : Die sanitätspolizeiliche Beaufsichtigung der Schulen und des Schulunterrichts. Halle, 1859.

Idem : Die Sorge für die Gesundheit in den Schulen. Henke's Zeitschr. f. d. Staatsarzneikunde, 1859, p. 343.

Simon, Jules : La réforme de l'enseignement secondaire. 2e éd. Paris, 1874.

Staude : Gutachten des Zwickauer Vereins über die sog. Luftheizung und deren Zulässigkeit in Schulen. Zwickau, 1874.

Thomé, O. W. : Schulgesundheitspflege. Cöln u. Leipzig, 1871.

Van der Burg : De Lucht in Schoollokalen. Nederland. Tijtschr. voor Geneesk. Mart., 1873.

Vernois, Maxime : État hygiènique des lycées de l'empire en 1867. Paris, 1869.

Varrentrapp, Georg : Der heutige Stand der hygienischen Forderungen an Schulbauten. Vierteljahrsschrift für Gesundheitspflege, 1869.

Virchow, Rudolf : Ueber gewisse, die Gesundheit benachtheiligende Einflüsse der Schulen. Berlin, 1869.

Voit, E., and Forster, J.: Studien über die Heizungen in den Schulhäusern Münchens. Zeitschr. f. Biologie, XIII. Bd., 1. H., 1877.

Walser, E.: Bericht über Schulbauten und Schulhygiene, im II. Theil des Bericht über österreichisches Unterrichtswesen. Aus Anlass der Weltausstellung, 1873; herausg. von der Commission für die Collectiv-Ausstellung des österreichischen Unterrichts-Ministeriums.

Wanzenried, Albert: Das physische Leben unserer Generation und die Volksschule. Bern, 1865.

Weber, Carl: Luft und Licht in unseren Wohnungen; populärer Vortrag. Darmstadt, 1869.

Winsor, Fred.: School Hygiene. Fifth Annual Report of the Massachusetts Board of Health, 1874.

Zahn: Die Schulbankfrage. Bayer. Intelligenzblatt, 1868, p. 8.

Zwez, W.: Das Schulhaus und dessen innere Einrichtungen. Weimar, 1864.

The reader may consult, among public documents and orders, the following:

Breslau (Royal Government). 1860–1866.

Baden (Oberschulrath). 1868: Relating to desks.

Baden (Min. of Interior). Feb. 26, 1869. Architecture.

Baden (Idem). April 23, 1869.

Bavaria (Interior). Jan. 16, 1867.

Bremen (Sanitary Association). 1869.

Saxony (Ministerial order). 1873.

Prussia (order relating to the higher and middle-class girls' schools). 1873.

Wurtemberg (Ministerial): Desks and seats. 1868.

Wurtemberg (Ministerial). 1870.

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